REJUVENATION OF THE DITCH
- REDEFINING THE LANDSCAPE OF THE EMBARRAS RIVER WITH INTEGRATED ANALYTICAL & DESIGN APPROACHES

BY

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THESIS

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ABSTRACT

This thesis aims to redefine the traditional rural landscape of the upper section of the Embarras River (UER) in Champaign County, Illinois. To date, there are four issues existing in this landscape: flooding, impaired waterway, extinction of endangered species, and lack of identity. Integrated with analytical and design approaches, the objective is to transform the site into an eco-friendly and recreational landscape for the sake of multiple benefits.

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CHAPTER 1: INTRODUCTION

1.1 Research Overview

Many rivers flowing through agricultural lands worldwide are found to have a variety of thorny issues, such as impairment caused by pesticide and herbicide runoff, species extinction resulting from poor water quality, and degraded landscape corridors that result from dredging and increased runoff volumes (from field tilling). This research seeks to help redefine the traditional river landscape in agricultural lands through analysis and design. The study area is the Upper Embarras River (UER); a section of the Embarras that flows from southern Champaign county to northern Douglas county in central Illinois. The UER was chosen for both its proximity (to campus) and because it exhibits many of the environmental and cultural problems associated with agriculturally defined waterways. In particular, although middle sections of the Embarras are designated as biologically significant, much of the river corridor is agricultural land uses. In fact, the UER is considered a 'ditch' instead of a river by many adjacent farmers . This study hopes to help define a pathway towards biological improvement.

1.2 Research Purpose

Generally speaking, this thesis aims to define a pathway to transforming the landscape corridors for rivers that cross agriculturally intensive lands. In detail, the research involves analysis and design for a specific site (the UER), which shares critical issues common to agricultural river corridors. Preliminary analysis reveals, there are four important considerations on the EUR: flooding, impaired waterway, extinction of endangered species, and the lack of identity. The objective of this study is to identify solutions through research and design that deal specifically with these four issues using the EUR as context. Likewise, the designs can be applied for other waterway landscapes with similar conditions.

1.3 Research Questions

This research focuses on the four issues noted above: flooding, water quality, habitat, and cultural identity. Generally speaking, riparian buffer zones function to improve water quality, and then to help the river provide better habitats for more species. Secondly, green and grey infrastructure is used for flood control. Thirdly, creating recreational greenways along the river helps enhance UER's identity, transferring the so-called ditch into a real river with higher reputation. This study aims to seek solutions to the following questions:

a. How to design riparian buffer zones with the purpose of improving water quality and increasing diversity of species (aquatic and terrestrial species) in agriculturally damaged waterway systems?

b. How to design green and grey infrastructures that increase diversity of species and relieve potential flood pressures downstream (in this case Villa Grove, IL)?

c. How to integrate recreational trails into a waterway ecosystem that enhances the site's identity and recreational potential?

1.4 Research Methods

The methods of this research involve literature review, data collection from various institutions and websites, data analysis, and site-specific research and design.

Literature review and data collection involves looking for data from, and communication with, diverse agencies including: Prairie Research Institute of University of Illinois at Urbana-Champaign, the USGS Water Science School, Illinois State Water Survey Watershed Science Section, the Illinois Department of Natural Resources, International Water Resources Association (IWRA) Student Chapter, and Wikipedia. Data includes historic data of the UER, GIS shape files of the river and surrounding environment, GIS floodplain maps, land use maps, river profiles data, etc. In addition, literatures and data specifically about the UER were also studied in order to figure out solutions to four issues of the site.

Based on the research of river characters and flood data, a series of water-related conditions were analyzed, from which diverse infrastructures with certain functions were proposed to hold certain amounts of water in order to relieve flood issue in Villa Grove.

Following the research phase is the site design on the UER. Aiming at four issues, three strategies are created to guide the final design, which are the most significant parts in this thesis research.

Finally, the designs on both large scale and small scale were created. In large scale, design strategies are applied to the river corridor. In small scale, two smaller-scale sites were chosen to develop detailed design as two scenarios for the project.

1.5 Significance

The thesis research seeks to find solutions for common issues of most rivers by studying on one specific site, which can also be applied to other rivers with similar situations. The history of waterways in agricultural lands was one of abuse, misuse and ignorance. Traditional approaches to these waterways only address a single issue, moving water downstream. To the contrary, this thesis provides multi-functional approaches involving ecological, biological and recreational considerations. In addition, most of traditional approaches are commonly defined as "hard" solutions, such as civil engineering solutions. However, this thesis extends the approach to "soft" solutions, including the integration of green and grey infrastructure, riparian buffer design, recreational opportunities, and aesthetic landscape.

In general, the strategies used in the study are interrelated with each other. For example, riparian buffer is listed as one category because of its remarkable functions to improve water quality and increase species. But riparian buffer is actually part of green infrastructure. So riparian buffer also functions to control flood. Moreover, according to ecological research, the river habitats associated with flooding river channels are the most ecologically valuable and diverse (Ward and Stanford, 1995; Ward et al., 1999, Naiman et al., 2005). It is suggested that solving the flooding issue in Villa Grove by setting aside a constructed floodplain is also considered as the method to improve water quality and increase biodiversity. Therefore, this study involves a sequence of approaches that act in harmony to deal with river landscape issues.

CHAPTER 2: LITERATURE REVIEW

2.1 Guiding Theory

The key of this thesis research originates from several fields in landscape architecture involving: landscape structure, landscape ecology, landscape infrastructure, and recreational landscape. To be more specific, several bodies of knowledge both inside and outside the Landscape Architecture discipline are included in this study:

a. river morphology theory
b. 3-zone buffer
c. hard and soft infrastructure
d. recreational greenway

2.2 River Morphology

River morphology theory is the most basic theory in this research. River morphology theory helps to understand the basic configurations of a river, including impacts of water flows, different zones along a meandering river, causes and impacts of different zones, etc. From this theory, buffers, water management infrastructures, and recreational greenways were also studied to cogitate how to apply these strategies in different zones based on river morphology theory, what the impact of these strategies are for the river, etc.

As for assessing water resources and managing coastal infrastructure, river morphology is of paramount consideration, especially in the use of the study segment of the Embarras River where the river has been dredged, stretched and generally compromised so that water moves very quickly at great quantities downstream (Figure 1). Many rivers have been straightened by engineers to increase its flow velocities. On the contrary, the longer, meandering river channel is able to storage more water. By meandering river channel, river itself is able to function as flood management by providing “live storage” (Mount, 1995), which is called in-river flood management. In Figure 1, two examples represent the difference between straightened river and meandering river. In channel A, the channel is 10 miles long. In channel B, the total distance is approximately 20 miles long. Water in channel B travels twice as far as in channel A, resulting in half of peak flow less than channel A. In such way, meandering river channel functions to control flood.

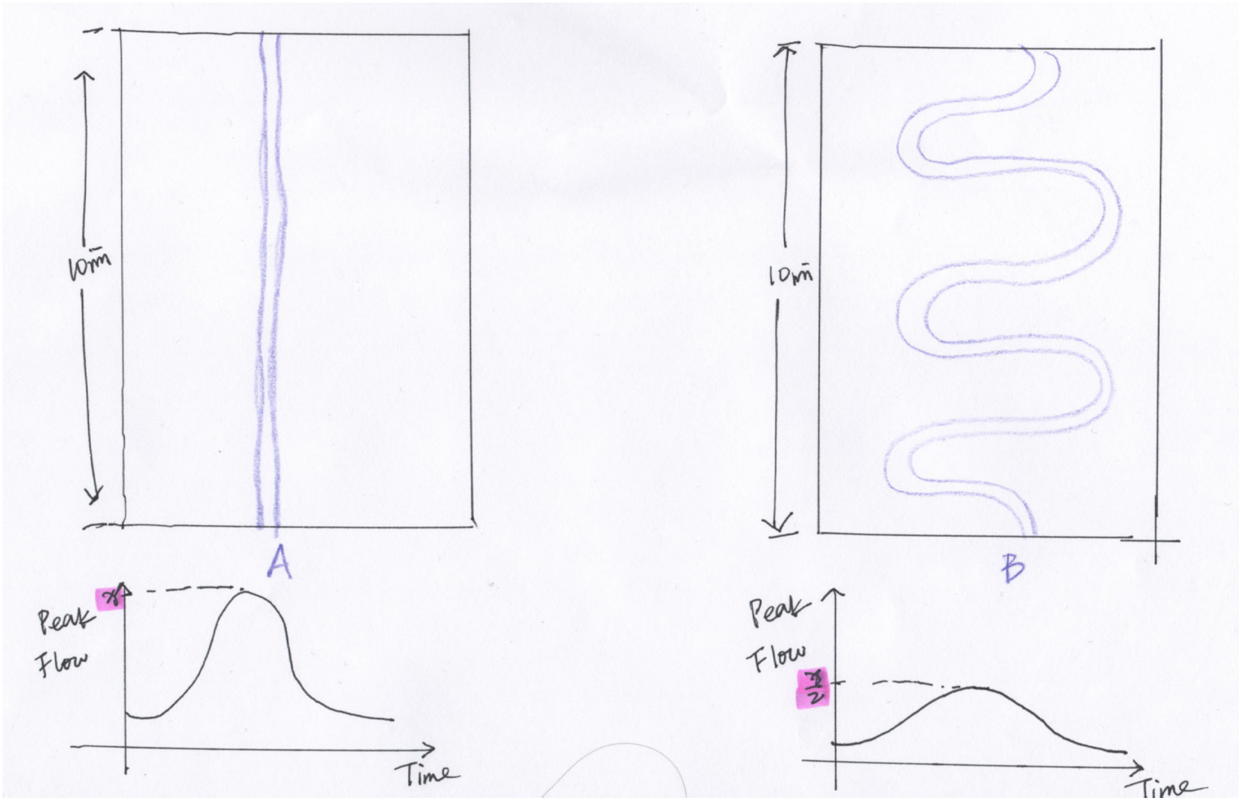

Figure 1 Straightened Channel vs. Meandering Channel
With the same area for river channels, straightened channel A on the left only allows water run 10 miles, while meandering channel B allows water run 20 miles, resulting in twice peak flows in channel A than channel B within the same amount of time.

It is also observed that river shapes are always varied with respect to channel processes, including erosion, corrosion, transportation and sedimentation (Matsuda, 2004). More specifically, meandering river morphology is herein discussed in the study. The landscapes of meandering rivers are formed by two processes, erosion and sedimentation. A meandering course may be formed by a stream of any volume, which can both alternately erode sediments on outer banks and be deposited on inner banks (“Meander,“ 2016). Because of water flowing, the velocity becomes higher on outer banks, while getting lower on inner banks. The distinction between water flow velocities in diverse areas incurs the bend to be more and more meandering. Erosion on the outer banks gives rise to cut banks for the meandering river and widens its valley. And sedimentation of silt on the inner banks forms deposition point bar. In addition, if the water breaks through levee during a flood; it would rush into the overbank area, spreading out and creating a fan-shape area called crevasse splay deposit (Figure 2).

River Morphology Theory

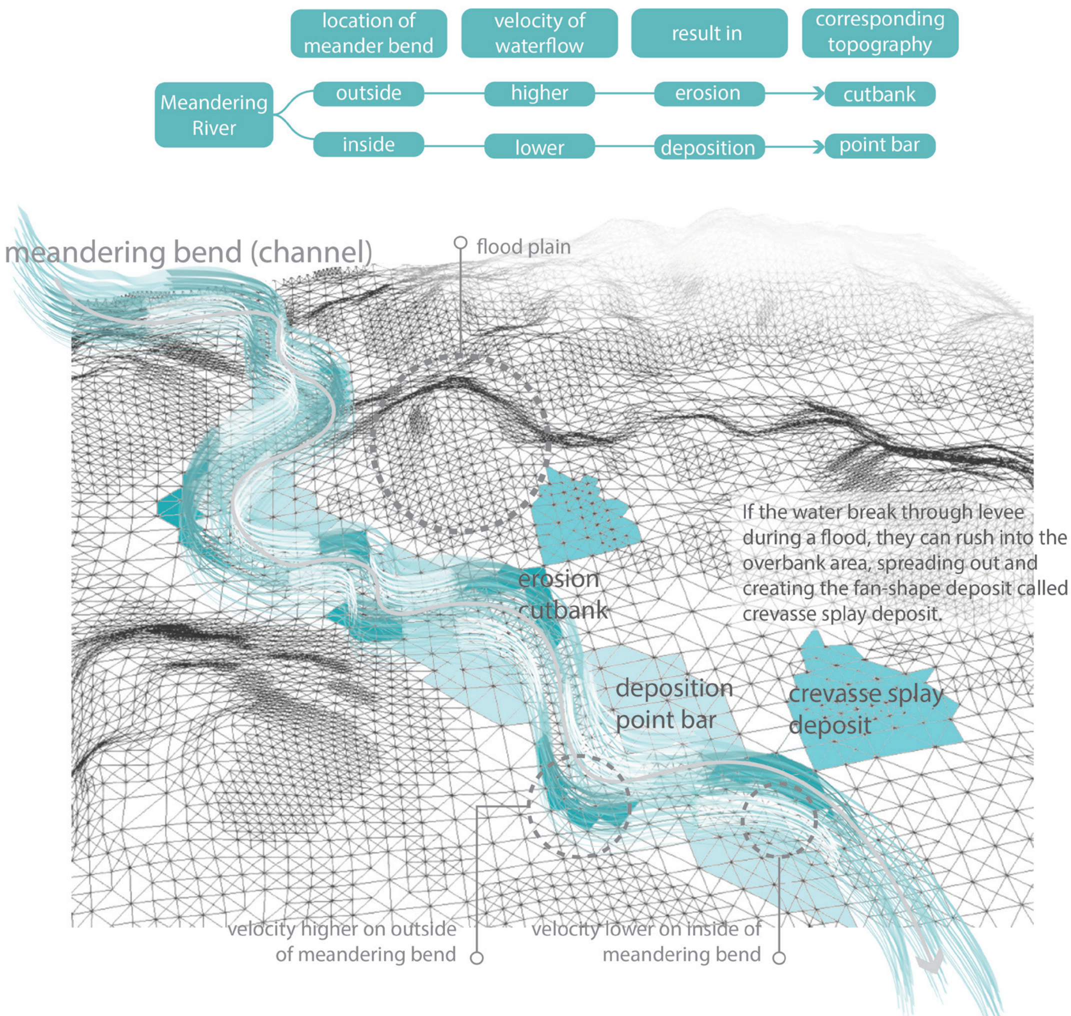

Figure 2: River Morphology Theory
Three zones are created by water flows with different velocities in different areas of meandering river bend: cut bank, point bar, and crevasse splay deposit.

Three zones are suitable for different landscape infrastructure, which will be amplified in Strategies section. Generally speaking, cut bank and crevasse splay are more suitable with retentions, detentions and wetlands. Water runs the fastest on outside of meandering bend, which means water will run out of river bend first into these areas. And then retentions, detentions and wetlands can function to hold flood water as soon as possible. Point bar fits for natural floodplain with riparian buffers. Point bars have a very gentle slope, so they are often overtaken by floods. Natural floodplains function to relieve flood water.

2.3 Riparian Buffer

Along the floodplains, rivers run through patches, corridors and matrixes in landscape structure, which is shown in Figure 2. A patch is a relatively small area that has more distinct structures and functions than the surrounding landscape. A river corridor is typically a linear patch. Furthermore, matrix is the background within which patches and buffers exist. In developed landscapes, patches are often remnant areas of woodland or prairie; corridors are linear elements e.g., windbreaks, fencerows, and riparian areas; and the matrix is usually developed lands including cropland or urban areas. The patches and matrix areas must be considered in the design of buffer areas. Location, structure, and management of nearby patches and matrix influence the types of functions that buffers will perform, and their effectiveness.

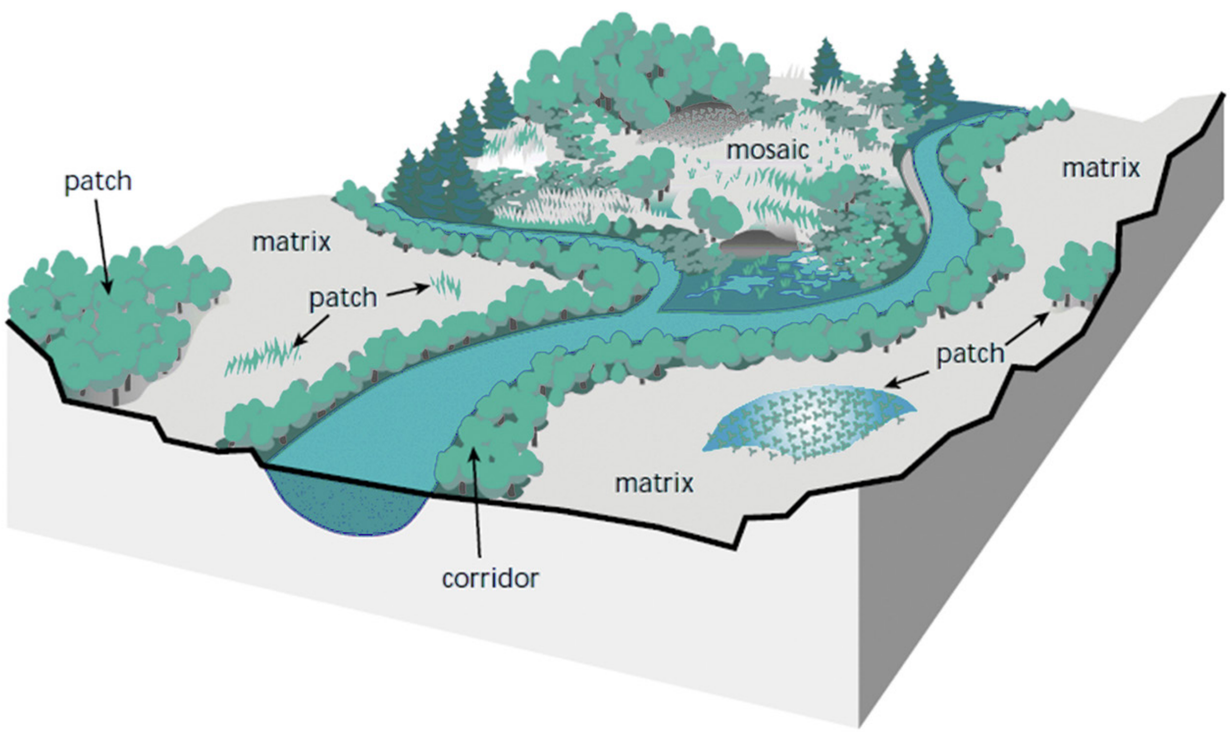

Figure 3: Patch, Corridor and Matrix in Landscape Structure
The functions and relations between patches, corridors and matrixes are significant to study the riparian buffer design. Buffers can only work well in the harmony with patches and matrixes.
Source: http://www.intechopen.com/books/advances-in-landscape-architecture/understanding-landscape-structure-using-landscape-metrics

Buffers are significant features in landscape design by integrating concepts in landscape ecology. Buffers may take different forms of planted areas along rivers and roads, corridors for wildlife habitats, or greenways on different conditions (Lovell & Johnston, 2009). As indicated in Figure 3, they can be designed into different functions. For example, buffers along rivers are claimed as the landscape for water quality improvement. Biological corridors are important for their role in connecting habitats for wildlife. And greenways allow movement of people for recreational and aesthetic purpose (Shafer et al. 2000, Hellmund and Smith 2006).

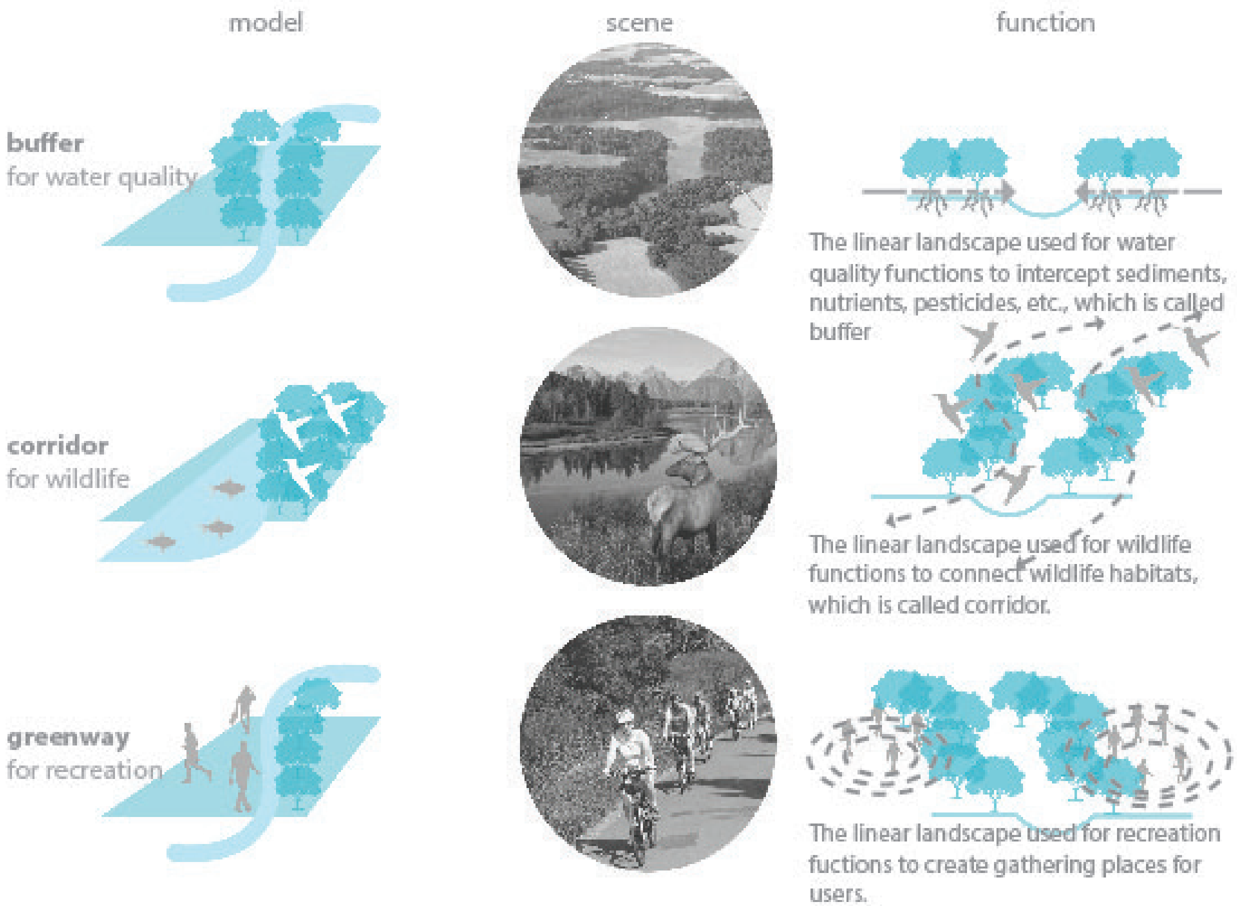

Figure 4: Linear Landscape Types
This diagram indicates three types of linear landscape based on their functions.

In detail, buffers function to improve water quality through their extensive root systems (Fischer et al. 2006). For example, their root systems trap nutrients entering from surrounding areas, such as phosphorous, nitrogen, pesticides and other chemicals (Lawrence et al. 2002, Lee et al. 2003). In addition, the root systems of perennials serve as strong infiltrator of water with their porous structures (Figure 5). Perennials' extensive root systems provide interconnected air voids to increase penetration rates underground. With such root structures, buffers function to control flood by increasing infiltration rates and slowing water flow (Schultz et al. 1997).

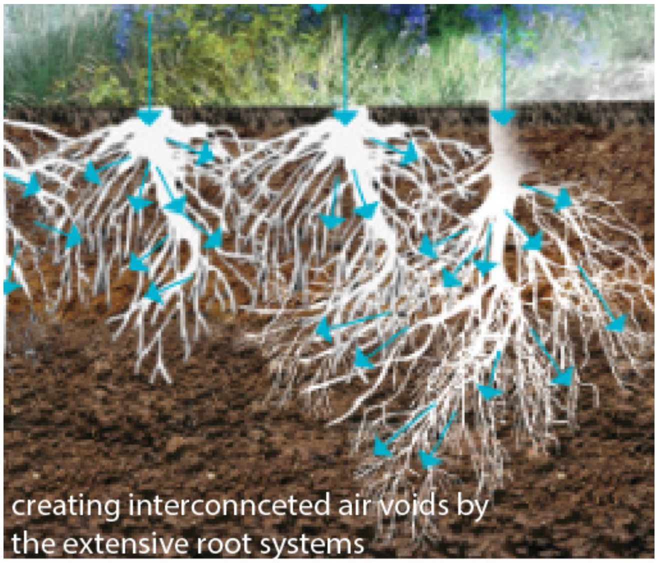

Figure 5: Extensive Root Systems of Perennials
The porous root systems of perennials can increase water infiltration by creating interconnected air voids.

As for biological corridors for wildlife, they are important to increase the biodiversity of fauna and flora by providing and connecting habitats for wildlife (Schultz et al. 1997). As mentioned above about three types of landscape structures, patches are small areas with distinct structures, providing habitats for wildlife. And corridors can serve as connectors of these patches with different structures. In such way, corridors provide opportunities for wildlife to move between fragmented patches (Schuller el al. 2000). As a result, corridors increase the biodiversity of fauna and flora.

Moreover, in the areas with more population, recreational greenways also function for cultural connectivity by allowing movement of people between communities with social, economic and recreational purposes (Shafer et al. 2000, Hellmund and Smith, 2006). Other functions like reducing noise (Thompson and Sorvig, 2000), filtering polluted air (Lovell and Johnston, 2009), managing microclimate with their shades (Bolund and Hunhammar, 1999), and mitigating unpleasant odors (Tyndall and Colletti, 2001) are also significant for landscape design.

Therefore, different functions of buffers can be considered in landscape design depend on the following elements: their configurations in landscape (Hellmund and Smith 2006), their relations with surrounding habitats (Schuller et al. 2000), and the combination of plant materials (Lovell and Johnston 2009).

As for targeting buffer zones, the theory is to place buffer zones along contour lines, because water will be trapped the most by the buffers perpendicular to the water flow, as shown in Figure 6. Moreover, riparian buffers are more effective along small and low-order streams than larger and high-order streams because more water delivered to channels from uplands enters along low-order streams (Bentrup, 2008). In addition, surface runoff from cultivated areas is higher in the areas where slopes are steeper and soils are finer-textured. Buffers designed in such areas will be more effective.

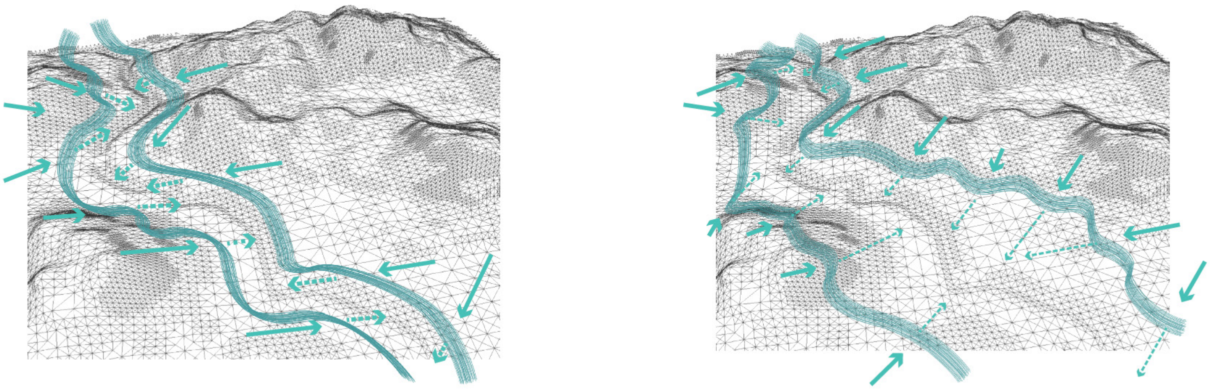

Figure 6: Representative Diagram of Targeting Buffers Zones
The diagram on the right indicates that buffer located along the contour can reduce the most runoff.

2.4 Grey & Green Infrastructure

Grey Infrastructure is typically considered traditional, constructed storm water management approaches of pipes, tanks, constructed detention and retention, and energy intensive treatment systems. Green Infrastructure is a landscape directed with infrastructures of bio-filtrations, ponds, wetlands, rain gardens and other natural land and plant based ecological treatment systems and processes.

Grey infrastructure is efficient in flood control, draining water as soon as possible. It is indispensible in urban (and peri-urban) water management. However, there are also many disadvantages. Historically, municipalities managed their storm water utilizing grey infrastructure practices made up of gutters, basins, and pipes that transport storm water quickly to local streams, rivers, and lakes. Many municipalities struggle to maintain this aging storm water infrastructure due to lack of funding. The result is frequent flooding and nonpoint source pollution degrading local watersheds. Additionally, in many older communities, storm water and raw sewage from homes and businesses flow through the same pipes to wastewater treatment plants. During heavy rain events, when the treatment plant reaches capacity, both untreated storm water and raw sewage are discharged directly to local streams and rivers through combined sewer overflows. Most basic grey infrastructures only single function. For example, some storm water pipe systems only function to drain water to relieve flood without treatment for pollution.

Green infrastructure is the interconnected network of open spaces and natural areas that naturally manages storm water, controls floods, improves water quality and captures pollution (Wise, 2008). Green infrastructures reduce overflow by evapotranspiration, capture and reuse of storm water, and promoting infiltration (U.S. EPA 2011). Green infrastructure technologies include green roofs, porous pavements, bio-retention facilities, storm water planters, etc. (De Sousa et al. 2012). Contrary to grey infrastructures, green infrastructures always function multiply. For example, retentions and detentions not only hold flood water, but plants in retentions and detentions also function to trap solids and some other pollutions in their root systems. Moreover, green infrastructures are also much more aesthetic than grey infrastructures, which is potential to provide open spaces for recreational uses. And by connecting green infrastructures together, it also connects habitats for wildlife. As for the cost evaluation, a number of researches suggest that under certain conditions widespread application of green infrastructure at reducing overflows is more cost effective than grey infrastructure (MacMullan and Reich 2007, Montalto et al. 2007).

Grey and green infrastructures have both pros and cons, so combining them will make the most use of them. As a result, for this study a hybrid infrastructure system will be developed and presented in the Strategies section.

2.4.1 Retention & Detention

The runoff treatment and flood control are commonly functioned by retentions and detentions (Krause, Groenleer, 2005). In detail, retention ponds are wet ponds holding a permanent pool of water, which are utilized to keep suspended particles and other solids in runoff at the bottom of the pond. In contrast, detention ponds are dry ponds that often give rise to the reduction of peak runoff rates and hold water flow for a short period of time around 24 hours. In addition, detention ponds also settle suspended sediments at the bottom of the holding area, preventing dissolved pollutants from moving into groundwater sources.

Based on scientific research, it is found that retention-detention units can significantly reduce peak and annual storm water runoff and sewer charge volumes (Locatelli et al. 2015). Retention-detention units refer to soakaways coupled with detentions. They function to reduce annual and peak storm water runoff, increase groundwater recharge, and reduce combined sewer overflows. The combination of retentions and detentions were first modeled to examine the impact on sewer charge and annual and peak storm water runoff (Locatelli et al. 2015). Figure 7 indicates how retention-detention combinations affect annual and peak runoff. To be more specific, allocating 20-40% of the volume to detention would reduce peak runoff to the most degree (80%) with big reduction in annual runoff (80%) as well.

As for the design of retention-detention units, four zones will be proposed according to

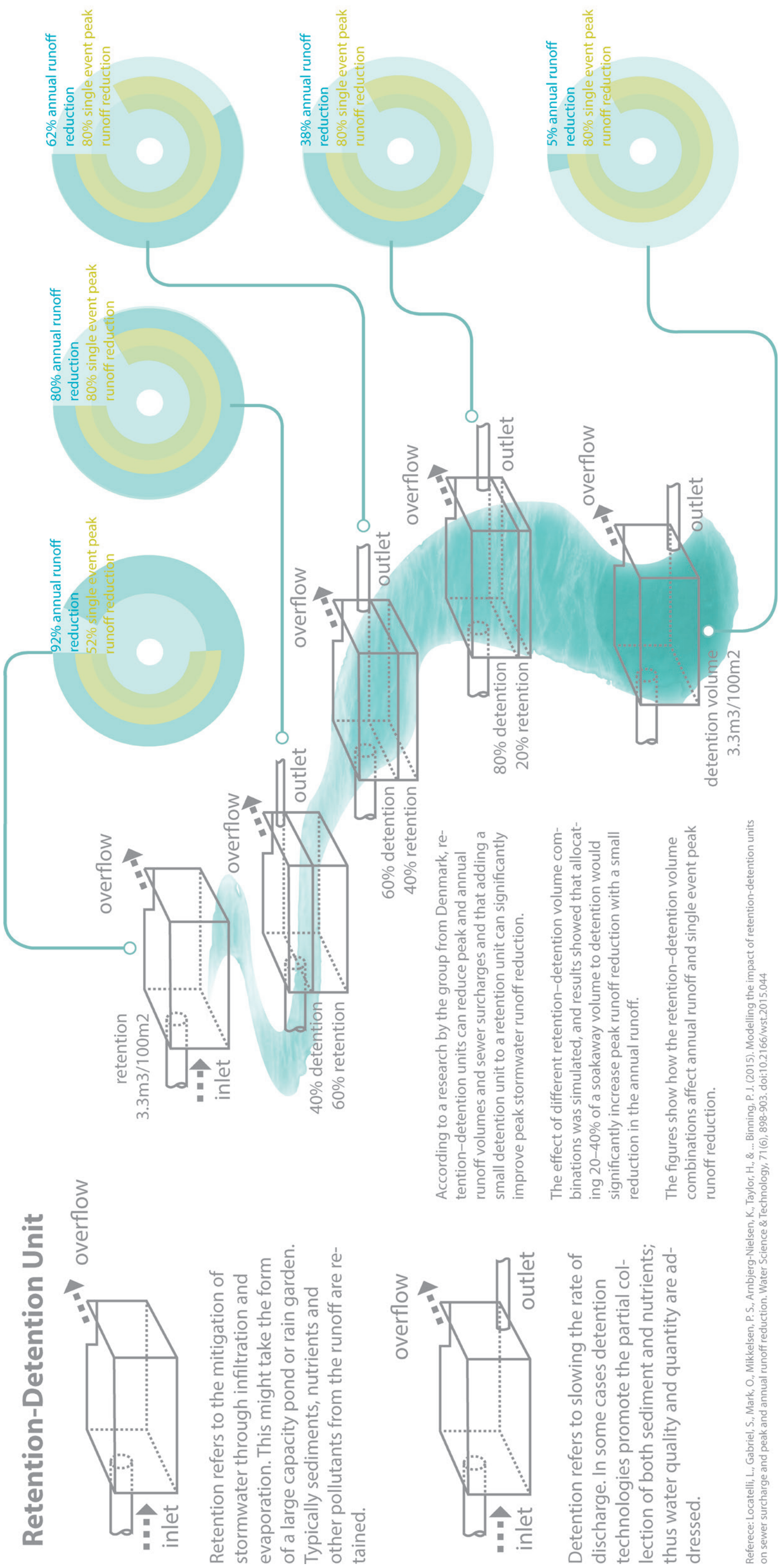

Figure 7: Retention-Detention Unit
This diagram indicateds the details of the scientific research about retention-detention unit, how to combine retention and detention to reduce annual and peak runoff to the most degree.

ecological and aesthetic considerations: emergent vegetation zone, saturated soil vegetation zone, submergent vegetation zone, and upland slope buffer zone (Figure8). Emergent plants grow in water but are partially exposed in air, in which their leaves can efficiently photosynthesize and compete from submerged plants ("Emergent Plant," 2016). Emergent plants are significant in stabilizing the shoreline. In addition, they are also important in nutrient cycling in river sediment (Ullah et al. 2014). For example, the research shows that NO3- attenuation is improved under emergent in river sediments. Saturated soil vegetation zone is for the vegetation growing in saturated or flooded soil, which is significant to stabilize the shoreline as well. Submergent vegetation produces oxygen, offers cover for fish and substrate for invertebrates, and acts as food for wildlife and fish (EPA).

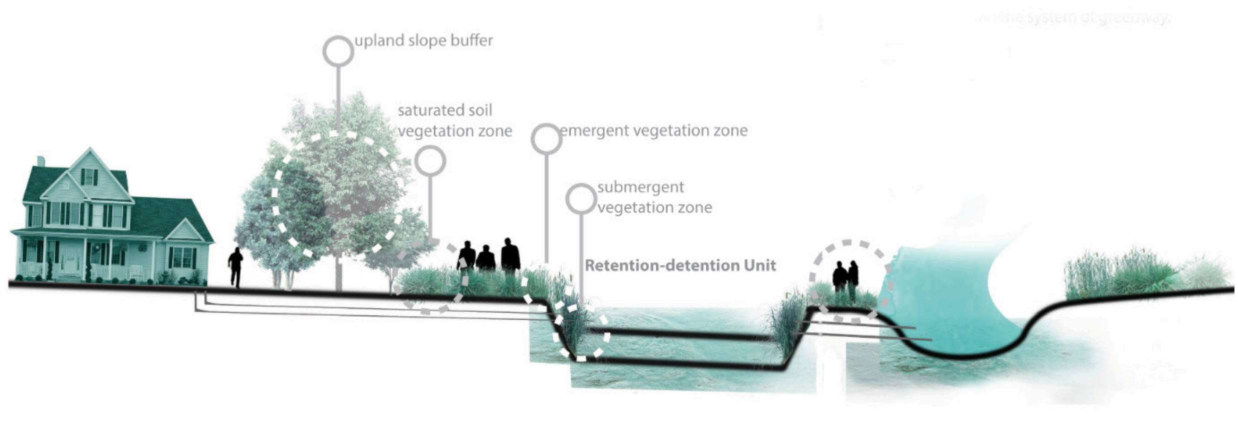

Figure 8: Retention-Detention Unit Design
There are four significant zones in retention-detention unit: emergent vegetation zone, submergent vegetation zone, saturated soil vegetation zone, and upland slope buffer zone.

2.4.2 Wetland
Comparable to coral reefs and rain forests, wetlands are considered as the most productive ecosystems (EPA, 2015). They provide habitats for an immense variety of species, such as insects, microbes, plants, reptiles, birds, fish, mammals, amphibians, etc. In detail, microbes, plants and wildlife that inhabits in wetlands offer global cycles for water, nitrogen and other nutrients (EPA, 2015).

In addition, wetlands have significant benefits to ecosystems and human society, including flood management (Vivian et al. 2014), water quality improvement (Weibo, et al. 2015), natural products at no cost, shoreline erosion control (Davis et al. 2015), and opportunities for aesthetic and recreational appreciation (Cottet et al. 2013). Furthermore, according to recent research, wetlands may also function for atmospheric maintenance (Pidwirny, 2011).

2.5 National Recreational Trail

Besides integrating ecological principles into landscape design, it is also important to consider social and cultural purposes. In the design of linear landscape, recreational trails are potential to be considered. There are trails on USDA lands that have been designated as National Recreation Trails (Figure 9). These agricultural-land trails all around the country present an opportunity to further increase the agricultural trails.

Farm-based recreational greenways are on a growth trajectory throughout the United States. There are more than 900 National Recreation Trails (NRTs) through the country that are totally more than 9,000 miles, which contributes to human health, recreation and conservation in the United States. In addition, farm-based recreation, including hunting, fishing, horseback riding rodeos, petting zoos and other activities, offered income to around 52,000 U.S. farms (2.5 percent of total U.S. farms) in 2004 (Brown & Reeder, 2007). Recently, agri-tourism is relatively popular worldwide, particularly in Europe; and it should be conducive to the improvement of U.S economy in the next decades, being viewed as an alternative way of farm income and as a approach for the diversity and stimulation of their economics in rural communities (Brown & Reeder, 2007).

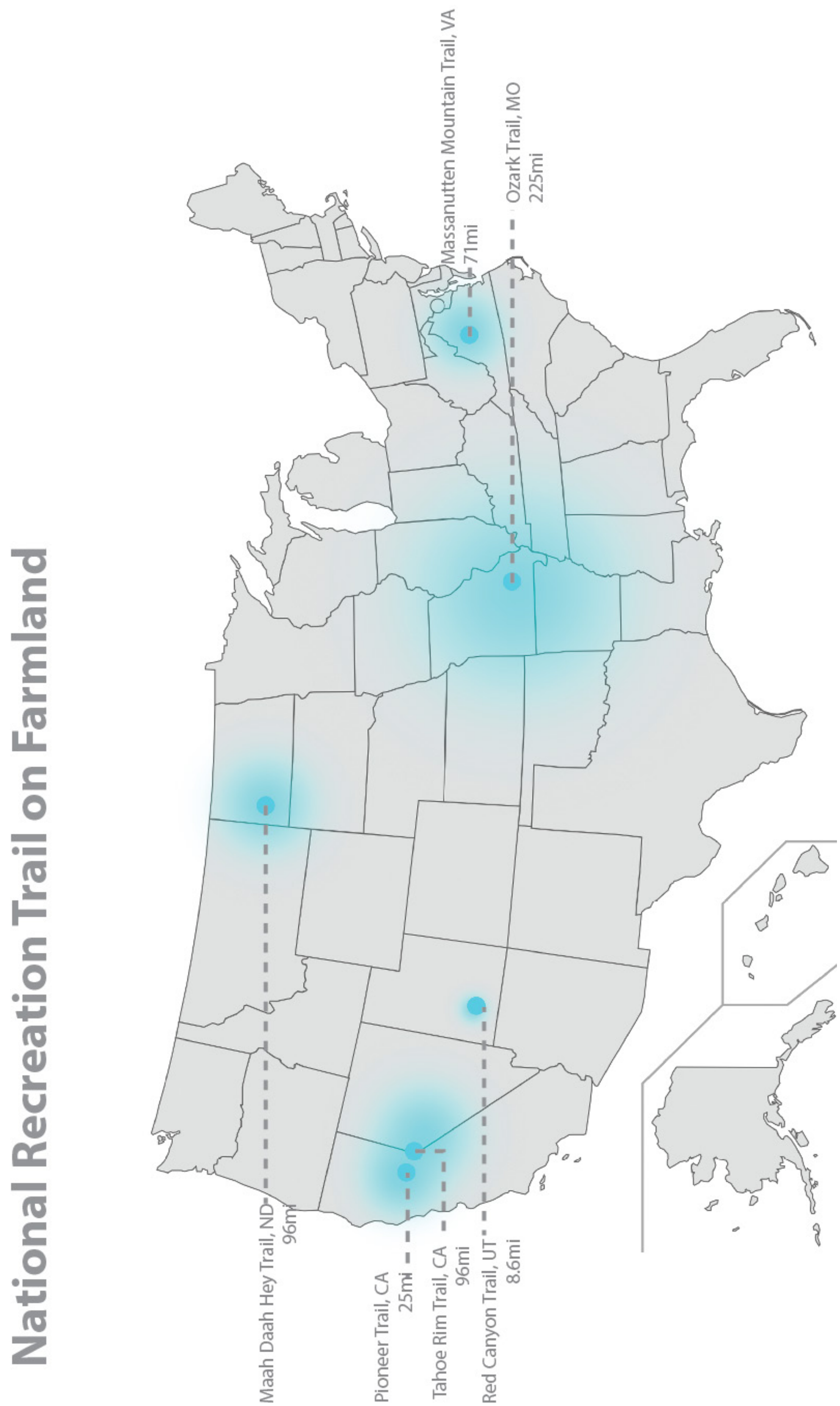

Figure 9: National Recreation Trail on Farmland
These are trails on USDA lands that have been designated as National Recreation Trails. These agricultural land trails around the country present an opportunity to further increasing of them.

CHAPTER 3: SITE STUDY

3.1 Site Description

3.1.1 Site Introduction

This study focuses on the upper section of Embarras River (UER) which is located close to University of Illinois campus. The whole Embarras River flows 195 miles (U.S. Geological Survey, 2011) through south central Illinois from Champaign County through nine other counties, Douglas, Coles, Cumberland, Jasper, Richland, Crawford, Lawrence, Vincennes and Indiana counties, to its confluence with the Wabash River (Wikipedia).

Flowing through agricultural land, the site faces a number of agriculture-driven problems, including water quality problem and biological extinction. Moreover, south of the research site located at the confluence of the major Embarras River and the East Branch Embarras River, Villa Grove has been experiencing severe flooding problem since 1950. In history, it was a biologically significant stream, which was unpolluted and mostly unmodified with state-threatened species. Despite of its significance in history, it is currently considered as a *ditch* rather than a river to adjacent farmers because of its highly degraded state.

3.1.2 Interview

In order to fully understand the site, several site visits were made. And residents both in Champaign and Villa Grove were interviewed for this thesis research. There was a serious flood in Villa Grove on December 26 and 27, 2015. Some Villa Grove residents were interviewed after the flood. Some resident said that many streets and allies that are soaked under water were closed; and some markets were closed during flood periods. There was even a foot of water in the basement of one resident's house. Moreover, according to the daily newspaper for East Central Illinois, the News-Gazette, an emergency curfew was issued by Mayor Terry Harbin at 8 p.m. on Sunday, December 27, 2015 until 6 a.m. on Monday, December 28, 2015 (Mitchell, 2015). Illinois Route 130 that runs through Villa Grove to Interstate 72 in Urbana was even closed due to the flood, which made people unable to go through Villa Grove form south to the north end of the town without driving a mile into the country.

Interviews in Champaign were also conducted. It turns out that Embarras River is not so well known to many people who live in Champaign. Some people had pronounced it 'embarrass' until I corrected them that it's pronounced 'EM-BRAH'. When some residents at Champaign and Urbana were asked if they know there is a river south of Champaign, some residents responded with "Oh, you mean the ditch across the farm land", while some UIUC students were even not aware of the Embarras River. All these evidences indicate that the Embarras River is lack of identity. However, there are some activities happening in the head water area (Figure 10). During one site visit, I happened to come across some people coming back from the 'lake' at the head water of the Embarras River that is blocked by shrubs and trees and forbidden with a sign saying 'DO NOT ENTER, authorized vehicles only' (Figure 11). A student who just came from the lake told me that the lake inside is an experiment field whose view is pretty beautiful. In fact, several experiment fields that are owned by UIUC are at the head water area of the Embarras River close to UIUC campus. In addition, there are some residential areas at the head water area that is potential for future development.

Figure 10: Photo of the Head Water Area of the Embarras River
The sign saying "this area has been cleaned by volunteers" indicates that there are activities happening at the head water area of the Embarras River.

Figure 11: Photo of the Head Water Area of the Embarras River
There is a lake at the head water area of the Embarras River that is blocked by shrubs and trees and forbidden with a sign saying 'DO NOT ENTER, authorized vehicles only'.

3.2 Site Issue

In order to gain full understanding of the site, several visits were made along the UER from the headstream to Villa Grove. Prior to on-the-spot investigation, background research on a range of relevant topics was made to get familiar with the basic conditions of the site. The site visits include interviews and discussions with residents in Champaign and Villa Grove, a visit to Villa Grove, observations of Villa Grove through historic photographs and other secondary sources, and visits to the central parts of the town.

By visiting the site and conducting research on its history and existing conditions, four critical UER issues were identified (Figure 12):

1. Flooding in Villa Grove
2. The physical impairment of the waterway
3. The potential extinction of endangered species from the site
4. A general lack of identity

Figure 12: Site Issues
The research and design in this site study are based on four issues of the site: flooding, impaired waterway, extinction of endangered species, and lack of identity.

3.2.1 Flooding in Villa Grove

Flooding in Villa grove is a continual and periodic issue. Many bridge decks and road crossings are flooded and overlapped by stream stages (flow elevations) during flood periods at frequent intervals (McConkey, 2002).

Villa Grove, located at the confluence of the main branch and the branch of the Embarras River, has been experiencing severe flood problems since 1950. Reported severe floods (over 100 year events) occurred in January, 1950; April, 1994; June, 2008; April, 2013 (Figure 13); and December, 2015 (Figure 14), respectively. In 1950 Villa Grove was isolated by flooding. It was reported that 100 families became homeless and more than 1/3 of the city was underwater (Harrisburg). The peak discharge at Villa Grove is 10,370 cfs (cubic feet per second) and 32 hours in 2002, which is tremendously high for this part of the country (McConkey, 2002). Figure 15 and 16 also indicate the details of the flood in 1950 in the Newspaper of The Daily Illini.

Figure 13: Images of Flooding in Villa Grove on Friday, April 19, 2013
Image Source: http://www.news-gazette.com/multimedia/photogallery/2013-04-19/rain-and-more-rain-central-illinois-flooding

Figure 14: Image of Flooding in Villa Grove on December 29, 2015
Image Source: https://www.youtube.com/watch?v=ax3GdZTHkSs

THE DAILY ILLINI

Serving Illini for Over Three-Quarters of a Century

79TH YEAR | EIGHT PAGES | URBANA-CHAMPAIGN, WEDNESDAY, JANUARY 11, 1950 | FIVE CENTS | NUMBER 71

Boneyard Plan May Receive Aid from UI

Soprano's Recital Presents Songs From Germany

Frank Scott Dies; Rites Scheduled For Saturday

News Briefs

AN INDIANA NATIONAL GUARD "duck" plows through flood waters of the White river, 15 miles north of Vincennes, Ind. City officials are aboard the "duck" to check water pumping stations, (background), which handle the town's water supply. The waters inundated farm land area north of town. The levee of the White river is also seen in the background.

Towns Offer More Law Openings Than Cities, Attorney Contends

Plays Scheduled By Workshop

Speaker Describes Group Leadership At SDA Institute

Wright Given Senate Post By Council

By VALERIE VANCE

Bud Wright was chosen freshman council representative to the student senate last night after lengthy discussion and two tie ballots.

The freshman representative's duties will be to attend senate meetings and report on discussions and motions to the freshman council. He is a senator ex-officio and holds all privileges except voting and sitting on major committees.

In a drawn-out two-hour meeting, the 13-man council also attempted to organize its policies on committee formation and social events. One suggestion for choosing freshmen to work on committees was to pick those who petitioned unsuccessfully for council membership by virtue of their interest.

The independent vs. Greek angle was brought in when one member suggested that independent students be fairly represented. They have a much larger number on campus and should be recognized, she said.

Committees will be split up tentatively into two major projects—freshman week activities and freshmen social activities.

The committee's program is based on suggestions submitted by council petitioners. Also included in semester's plans is improvement of the freshman handbook.

Election of Francis J. Koenig, assistant dean of the college of liberal arts and sciences, was also discussed. Koenig was chosen last ...

First Dollar Day In 1950 Planned

Employes' Group Declares Profit For Half-Year

Candy Machine Sales Pay Off Dividends To Nonacademics

... laboratories and stores, food service, and supervisory and administrative. The dividend payments are made according to the number of employes in each group.

Following the council's canteen policy, the money will be used for the promotion of employe welfare and activities. This policy reads: "All expenditures shall be made for improving employes' morale, cooperation, acquaintance, working conditions, or general well-being, and shall be limited to the promotion of such activities and purchase of such supplies and equipment as shall bring about results as above noted."

Magazine Raps CSEC

(The Illinois Technograph, college of engineering magazine, editorialized against the use of these profits in the December issue, and questioned the near-monopoly position of the council in the operation and ownership of coin machines on campus.)

The council also approved the appropriation of funds for sponsoring the non-academic recognition exercises scheduled late in February.

The ceremonies will be held to honor those employes who have successfully completed evening classes given this semester by the division of University extension.

Professor, Stipes State Appointees

SPRINGFIELD —(AP)— Carroll C. Wiley, University professor of highway engineering, and Royal S. Stipes, Champaign, president of the Illinois State Chamber of Commerce, were two members named by Gov. Adlai Stevenson yesterday to head committees of a state highway program.

The governor appealed to presidents of about 50 state-wide organizations for public support and assistance to "radically reduce the toll of human lives and of human suffering" from highway mishaps.

In the first 11 months of 1949, automobile accidents in the state killed 1,602 persons and injured 56,000 others.

The meeting voted to set machinery in motion for a statewide traffic safety conference at Springfield next April. B. B. Burns, Decatur, chairman of the Illinois inter-industry highway safety commission, was named conference chairman.

The following committee heads were appointed:

Planning—Mayor Ernest Hoagland, Jacksonville.

Laws and ordinances—Aubrey Yantis, Shelbyville attorney.

Accident records—Frank Hawk, Peoria insurance man.

Education—Mrs. Russell Oplinger, Decatur, president of the Illinois Congress of Parents and Teachers.

Enforcement—Royal S. Stipes.

Engineering—C. C. Wiley.

Motor vehicle administration—J. J. Cavanagh, vice president Chicago Motor club.

Public information—Basil Walters of the Chicago Daily News and Oliver Keller, Springfield radio station operator, co-chairmen.

UI Departments Asked To Submit Proposals

Hands-off Policy in Formosa Reemphasized by Acheson

Secretary Calls Pacific Area 'Impregnable,' After Closed-Door Session, Says Connally

WASHINGTON — (AP) — Secretary of State Acheson yesterday upheld the administration's stand against military intervention on Formosa.

He was reported to have said the United States could do more to combat Communism in the seething Orient through economic aid to lands still outside the Red orbit.

Chairman Connally (D-Tex) told reporters Acheson expressed that view in a day-long session with members of the Senate foreign relations committee which Connally heads.

The Texan also quoted the secretary as saying that regardless of Formosa's fate this country has an "impregnable" defense line in the Pacific without making use of that island stronghold.

Statement Disputed

But two committee members who asked their names to be withheld disputed Connally's statement that Acheson had termed America's Pacific defenses "impregnable." They quoted the secretary as saying that he was not qualified to pass on military strategy and any such appraisal would have to come from the joint chiefs of staff.

Among those attending the closed-door session was a group of Republicans who have been demanding that the United States extend direct military aid and guidance to help Chiang Kai-shek's Nationalist forces keep Formosa out of the hands of the Chinese Reds.

U. S. to Offer Aid

Connally said Acheson, however, reaffirmed the policy that President Truman took last week in announcing that this country will offer only economic assistance to the embattled Nationalists.

The secretary also made the further point, Connally said, that future recognition of the Chinese Communist regime will depend on how it demonstrates its willingness to abide by international law and protect American citizens and property.

Equipment Sent

While Acheson was testifying, news dispatches from Philadelphia disclosed that nearly 300 surplus U. S. Army tanks and armored cars were being loaded aboard a Turkish freighter for shipment to the Formosa defenders.

Officials here explained that this did not conflict with President Truman's stand against further military aid to the Chinese Nationalists. They explained that the Chinese bought the tanks with U. S. funds granted them last year, and that there was nothing in the Truman policy, as stated last week, to prevent the Chinese from buying arms in this country if they have the money.

China Buys Vehicles

The Chinese embassy said the combat vehicles were purchased out of the $125,000,000 China aid fund Congress voted in 1948.

Connally said the secretary did not lay down a specific blueprint of the proposed economic aid to halt the spread of Communism in the Far East. He said Acheson suggested that such help be given under Mr. Truman's "point four" program to assist undeveloped countries with scientific guidance, plus a government-backed program of private investments in overseas projects.

Schneider Cites Role of Selling To Engineers

Sales Manager Tells Future of Salesmen In Manufacturing

By SHELDON MIX

C. I. Schneider, sales manager of the Electro Manufacturing corporation of Chicago, said last night all the world is a showroom and all the people in it salesmen.

Speaking in the Electrical Engineering building before a gathering of the student chapter of the Illuminating Engineer's society, Schneider continued, "Some are good salesmen and others are bad salesmen." He emphasized that sales and engineering were one and the same thing, and said, "We need sales-wise engineers as well as laboratory-wise engineers."

Salesman's Ideas Praised

Given frequently to parodizing familiar aphorisms, Schneider made this assertion, "Show me a successful man and I'll show you a successful salesman." Many top ideas and systems used in industries today, he said, were conceived in the minds of salesmen. Schneider said the day when sales jobs were given to men who could do nothing else is over.

"Salesmen today are respected for their advice and their opinions," he said, "because they mingle with the customers and know what the needs of the people are."

Schneider informed the illumination fledglings that out of 250 company presidents, 48 per cent began their journey to the top in sales jobs.

One-Man Units Declining

He said in the last half of this century sales careers will come more into their own, and flatly stated that "one-man organizations are a thing of the past."

Going into history for another illustration, which he parodied, Schneider recalled that Napoleon said, "There's a major's baton in every private's knapsack." "I say," Schneider declared, "There's an executive's job in every salesman's brief case.

"The days of the back-slapping salesman are gone," Schneider remarked. "Selling today is a science, although not an exact science. To each job," he said, "we must bring our native intelligence."

The old definition of the salesman, the sales manager said, was, "One who persuades you to buy something you don't want and not at that price." This has all changed, Schneider continued, until now the duty of the salesman is "to provide products that won't come back to customers that will."

Today's Weather

Generally fair today. Tomorrow increasing cloudiness and warmer. Variable winds 8 to 12 miles per hour today. High today 32, low tonight 20, high tomorrow 42.

'Danger' Signs Don't Frighten UI Students

"Danger . . Don't look inside!"

That's what the sign on the ...

Villa Grove Asks Flood Controls

More than 200 citizens of flood-battered Villa Grove demanded in a mass meeting Monday night that a program to curb the rampaging waters of the Embarrass river be adopted.

Irate townsmen voted to renew a request for government aid in the control of the river and at the same time organized a "dollars for drainage" campaign to collect money from families in the flood area to aid in a local program. Members of the meeting contributed approximately $100 before they adjourned.

A novel method of supporting the drive for federal aid was also devised at the gathering. Townspeople have been asked to present a letter addressed to a congressman urging aid in the project when they pay their water bills in the city clerk's office.

John Henson, temporary chairman of the group, explained that the Embarrass river had been surveyed in 1943 by the Army engineers, and that they had recommended dredging the river and the construction of a dam and reservoir two miles south of Charleston to hold the Embarrass waters. Government aid was promised at that time, Henson said, but it never materialized.

FEBRUARY GRADUATES

JOIN NOW AND SAVE!

	Special	Regular	Savings
One Year	$ 1.00	$ 4.00	$ 3.00
Four Years	4.00	16.00	12.00
*Life Member	70.00	80.00	10.00

*Payment Plan—$75—$15 Down, $15 a year for four years.

U. of I. ALUMNI ASSOCIATION

227 ILLINI UNION

Figure 15: Newspaper in 1950 Reporting Flooding in Villa Grove

The contents in red rectangle are the information of flooding in Villa Grove.

Image Source: Villa Grove Asks Flood Controls. (1950, January 11). The Daily Illini, p. 1.

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Figure 16: Zoom-In Content of Flooding in Villa Grove from the Newspaper
Image Source: Image Source: Villa Grove Asks Flood Controls. (1950, January 11). The Daily Illini, p. 1.

3.2.2 Impaired Waterway

According to 303(d) list, most areas of Embarras River are defined as an impaired waterway. Pollution is mainly derived from nonpoint source, industrial and residential sewage treatment, among other sources. The Embarras typical suffers form nutrient loadings that are the result of adjacent agricultural practices. These pollution sources result in hypoxia (oxygen depletion), eutrophication and sedimentation, which seriously threaten the ecosystem of river.

3.2.3 Extinction of Endangered Species

The midsection of the Embarrass River is designated as a Biologically Significant Stream. And the UER was also a biologically significant stream in history. The extensive sand-and-gravel substrate of the midsection of the river provides habitat for a number of rare species, such as the harlequin darter, eastern sand darter, big-eye shiner, and blue sucker. Mussel diversity is high and the river has historically supported eleven state-threatened or state-endangered species. However, because of the impaired waterway, these endangered species are threatened.

3.2.4 Lack of Identity

The Embarras River rises in Champaign County. The upper reaches of the Embarras include the detention ponds near the intersection of Windsor Road with U.S. Route 45 in southeastern Champaign. This upper part is called as ditch by some even though it is an important portion of the Embarras. Compared to the midsection of the Embarrass River, which is designated as a Biologically Significant Stream, the upper portion has the potential to be well designed to extend the significance of the midsection. Its designation as a 'ditch' by adjacent landowners is generally due to a lack of sensitivity to importance of the stream. Over the years these landowners have straightened, dredged, denuded of vegetation, and degraded its banks so severely that its historic pristine river state is a distant memory for them.

CHAPTER 4: STRATEGIES

Based the above analysis, 3 strategic interventions were identified that might be used to cope with UER issues and enhance its potential as a valued Illinois waterway.

1. establish a buffer zone
2. amphibious infrastructure / hybrid infrastructure
3. recreational greenway

4.1 3-Zone Buffer

In the buffer theory part, you can see the issues and objectives corresponding to various buffer functions. By digging more into these elements, many close interrelationships have been determined, which are vital to propose the design strategies.

By reducing erosion and diffuse pollution, buffers on agricultural land have been manifested that have an essential role in protecting water quality of rivers (Christen, Dalgaard, 2012). Moreover, they have been demonstrated vital in flood mitigation, environmental conservation, etc. It is discerned that vegetated buffer zone can assist in the reduction of nutrients and pesticides losses from agricultural land (Dalgaard, Olesen, Petersen, Jorgensen, Kristensen, et al., 2011). Besides, vegetated buffer zone may contribute to managing the cycles of nutrient and water, mitigating flooding, improving carbon sequestration, and reducing gas emissions through petroleum fuel substitution (Dalgaard, Olesen, Petersen, Jorgensen, Kristensen, et al., 2011). It is also noticed that vegetated buffer zones can have a crucial influence in enabling a net energy production regarding agriculture. (Dalgaard, Olesen, Petersen, Jorgensen, Kristensen, et al., 2011).

In the UER buffer zone strategy there are primarily three zones in buffered areas:

1. Undisturbed forest: tree roots help stabilize the stream bank. Trees provide shade and help cool the stream
2. Sediment is trapped within the forest floor. Nutrients are bound to soil particles and taken up by vegetation. Zone 2 can be managed for the harvest of trees and other forest products.
3. Grasses help control runoff and encourage infiltration of water and pollutants into the soil.

Corresponding to different topographies, conservation objectives, personal preferences and harvesting technologies, different buffer designs will be generated. There are three scenarios in total, which are indicated in master plan in Figure 17. Furthermore, a zoom-in master plan describes the three zones in detail (Figure 18).

Figure 17: 3-Zone Buffer Scenarios
3-zone buffer scenarios are indicated in this master plan with different colors.

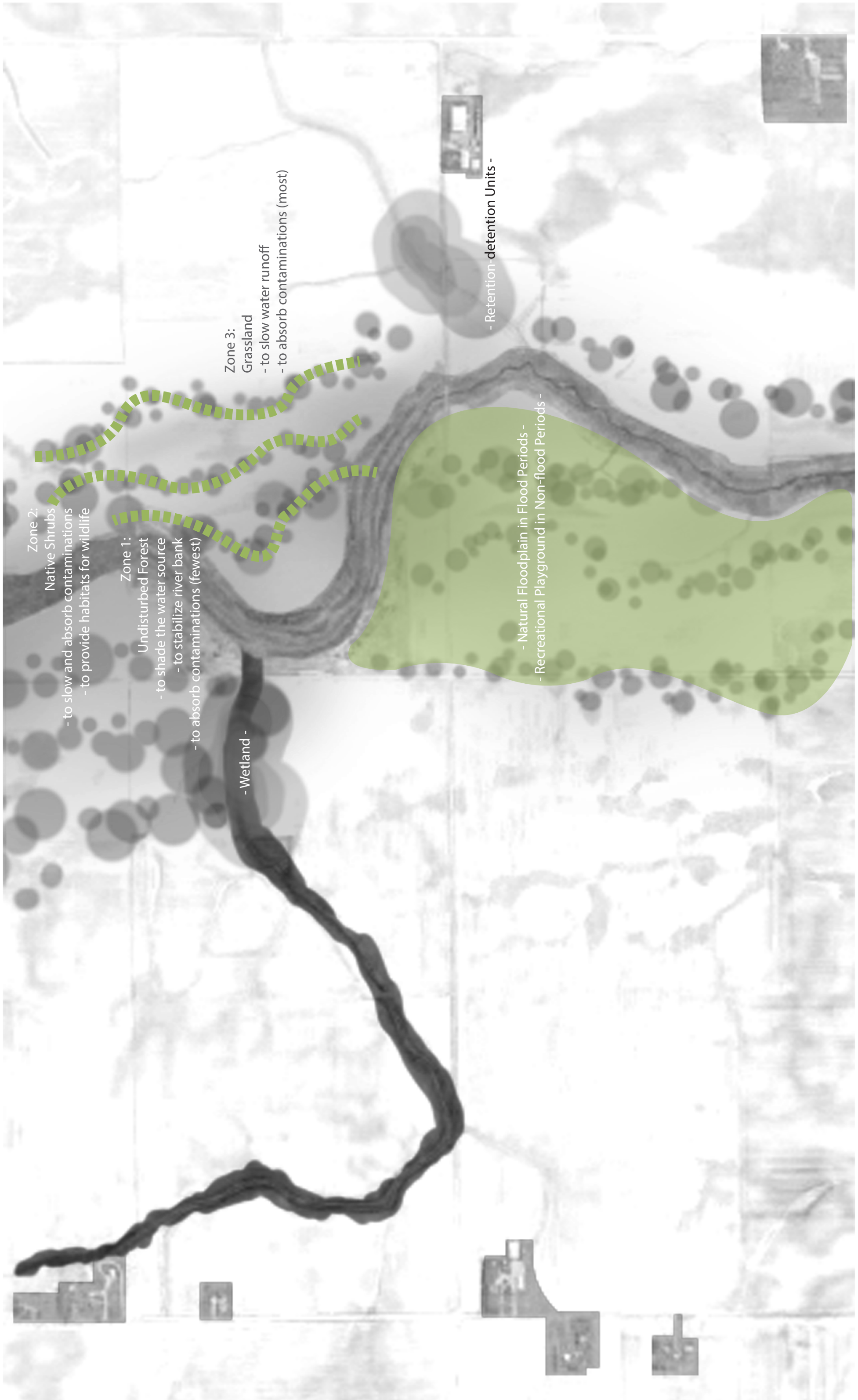

Figure 18: Zoom-In Master Plan of 3-Zone Buffer
The zoom-in master plan indicates the design of 3-zone buffer in detail.

Three scenario designs are based on the professional research of buffer design. Figure 19 demonstrates the existing condition of the site and the proposed buffer scenarios.The first scenario is for the river next to the cropland. High-energy yield buffers are designed on very low slopes; and multi-purpose buffers are designed on low to intermediate slopes. On very-low-slope site, three zones in this scenario involve fast growing grass area (20 feet), short rotation coppice area (23 feet), and short rotation forestry area (23 feet) (Christen, 2013). On low-to-intermediate-slope sites, three zones in this scenario involve forage or wildlife mixtures area (25 feet), multi-species short rotation coppice area (23 feet), and short rotation forestry area (10 feet).

The second scenario is designed for the river next to the residential housing. The design of retention-detention unit is based on the scientific research on sewer surcharge and runoff reduction. Three zones are upland slope buffer zone, saturated soil vegetation zone, and water-front vegetation zone. Water-front vegetation zone includes emergent vegetation zone and submergent vegetation zone.

Finally, buffer zone for forest area is deliberated as an integrated system closely related to human activities. In this scenario, forest has been functioned as great buffer for river. Pedestrian pathway is designed for recreational purpose between trees, by which residents can interact with nature to a large extent.

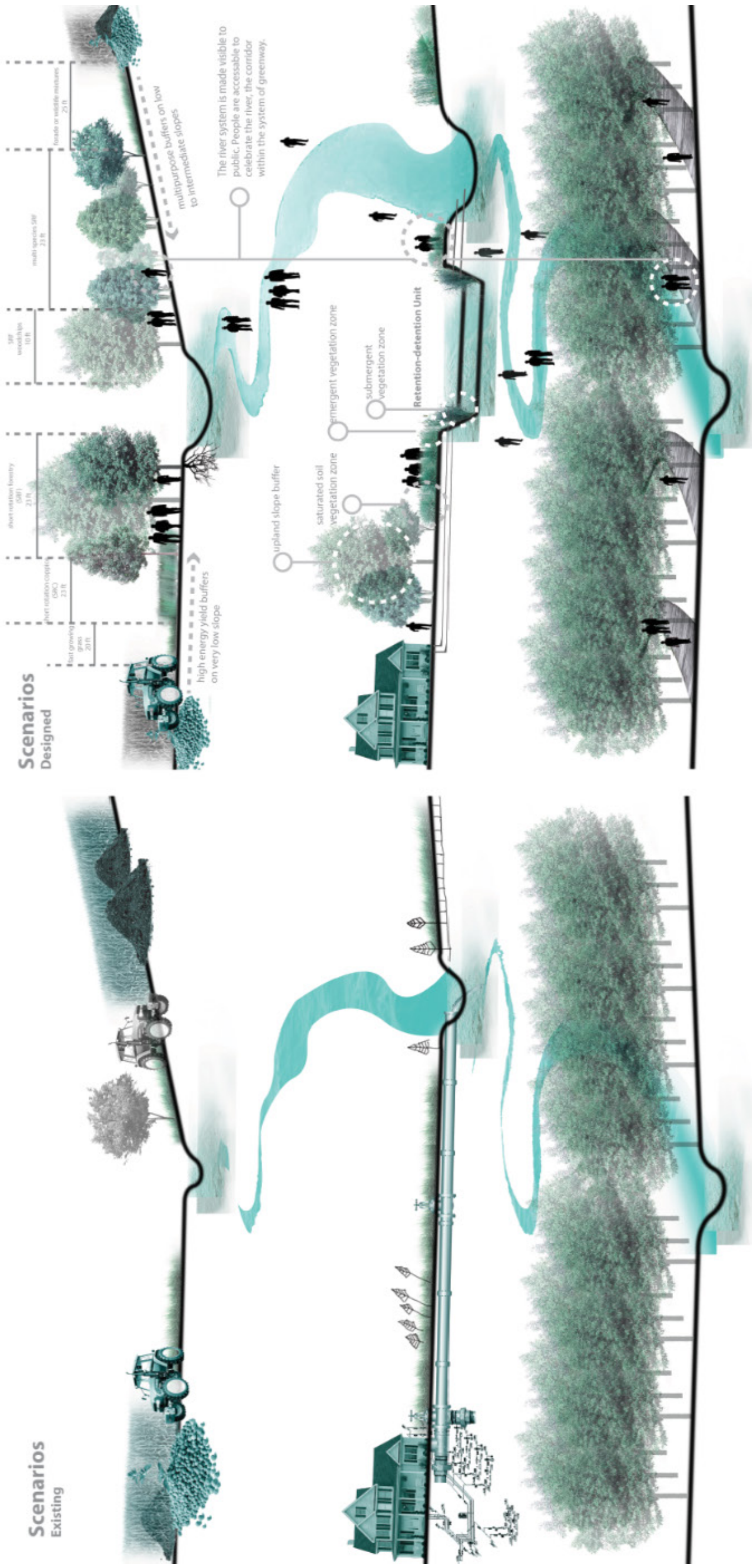

Figure 19: Existing Site Scenarios vs. Proposed Buffer Scenarios
Existing site scenarios and proposed buffer scenarios are created based on different site conditions.

4.2 Hybrid Infrastructure

According to ecological research, the most ecologically valuable and diverse river habitats are dynamically migrating, flooding river channels (Ward and Stanford, 1995; Ward et al., 1999, Naiman et al., 2005).

An amphibious infrastructure strategy is developed to let the river flood to relieve the flooding issue in Villa Grove. The reason of naming this strategy amphibious infrastructure is the infrastructure on this site provides various functions for both flood and non-flood period. It benefits both Champaign and Villa Grove communities, as well as explores the biggest potential of the river system. Figure 20 and 21 show the proposed perspectives in flood and non-flood periods respectively.

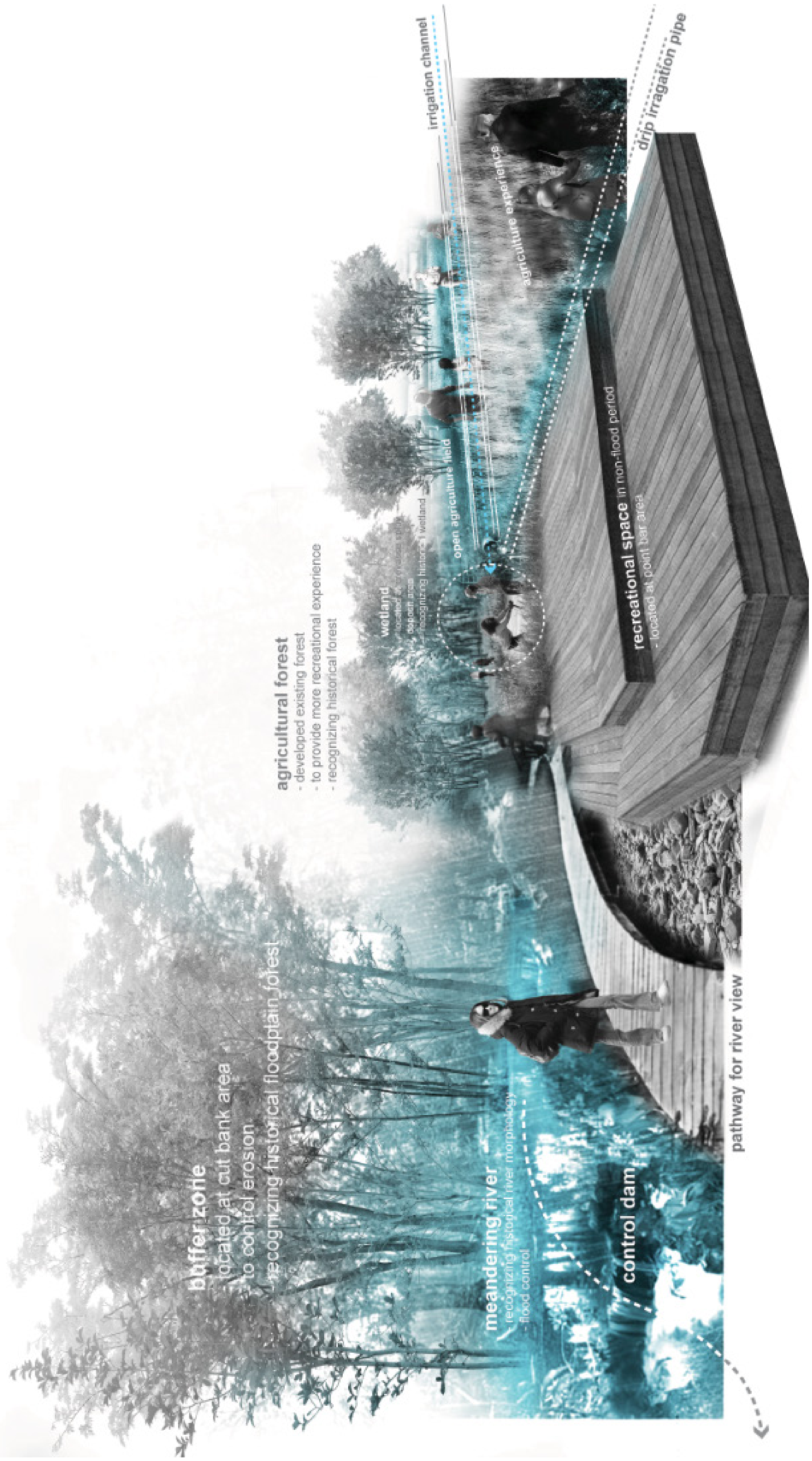

Figure 20: Proposed Perspective in Non-Flood Period
The proposed landscape in non-flood period acts as ecological and recreational space, providing recreational place for residents, as well as ecological space for water treatment, wildlife activities, etc.

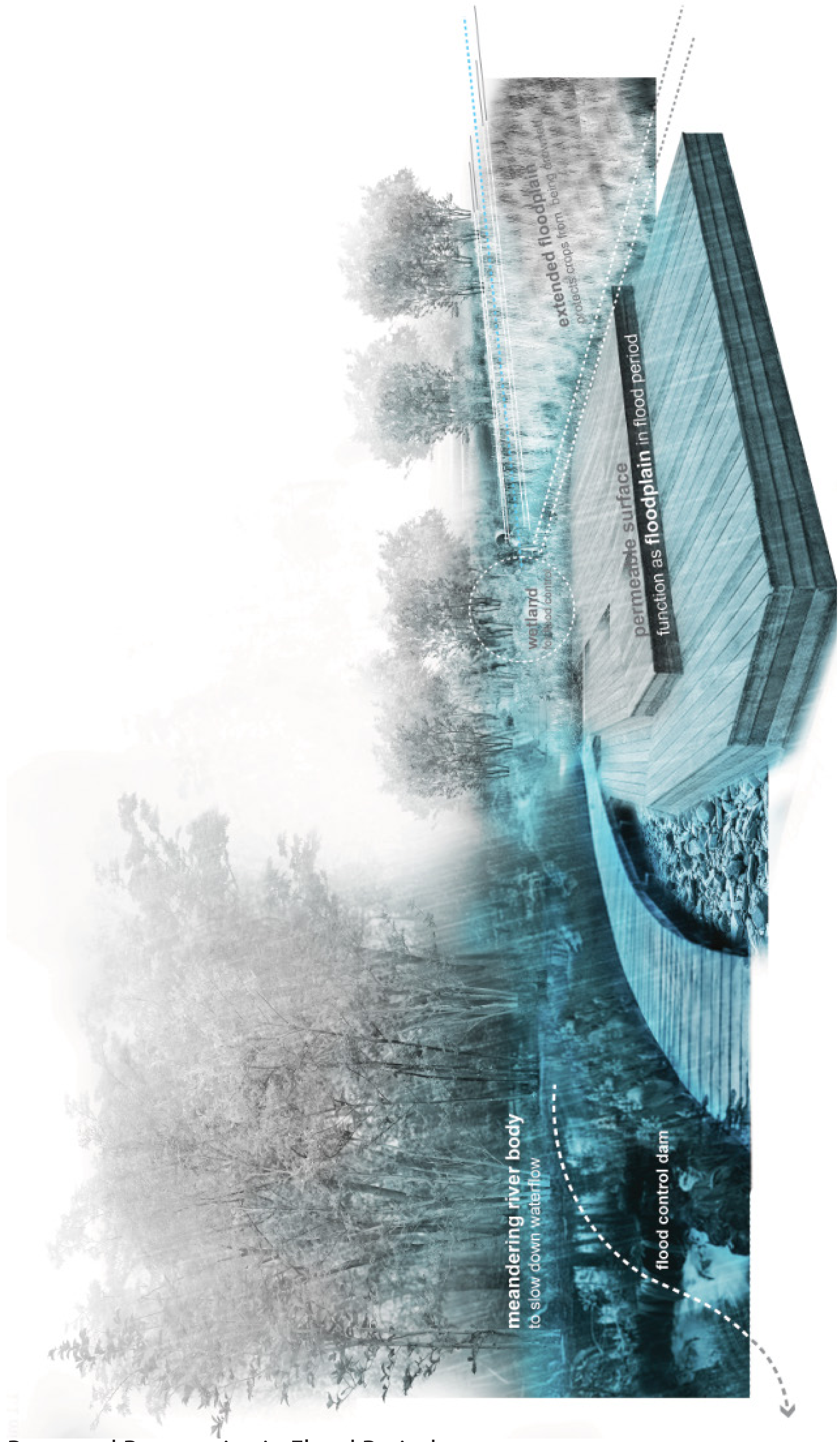

Figure 21: Proposed Perspective in Flood Period
In flood period, the proposed landscape acts as ecological space to control flood, improve water quality, etc.

In addition, the hybrid infrastructure means the hybrid of green and grey infrastructure. Guided by river morphology theory, there are three zones for meandering river that is vital for design (Figure 22). Based on this, I propose different infrastructure on these three zones, as demonstrated in Figure 23. In detail, with higher water flow velocity outside the meandering bend, erosion happens leading to the formation of cutbank area. In this zone, green infrastructure, such as buffer zone and retention-detention unit, is designed to reduce erosion. With lower water flow velocity inside the meandering bend, deposition will be developed into point bar area. As for such zone, low maintained lawn is designed, providing permeable surface playground for residents' recreation in non-flood period, as well as serving as floodplain to let it flood in flood period. Additionally, water rushes out to form crevasse splay deposit area in the fastest area outside the bend, which is designed to wetland to let it flood. Different zones are indicated in the large-scale master plan in Figure 24.

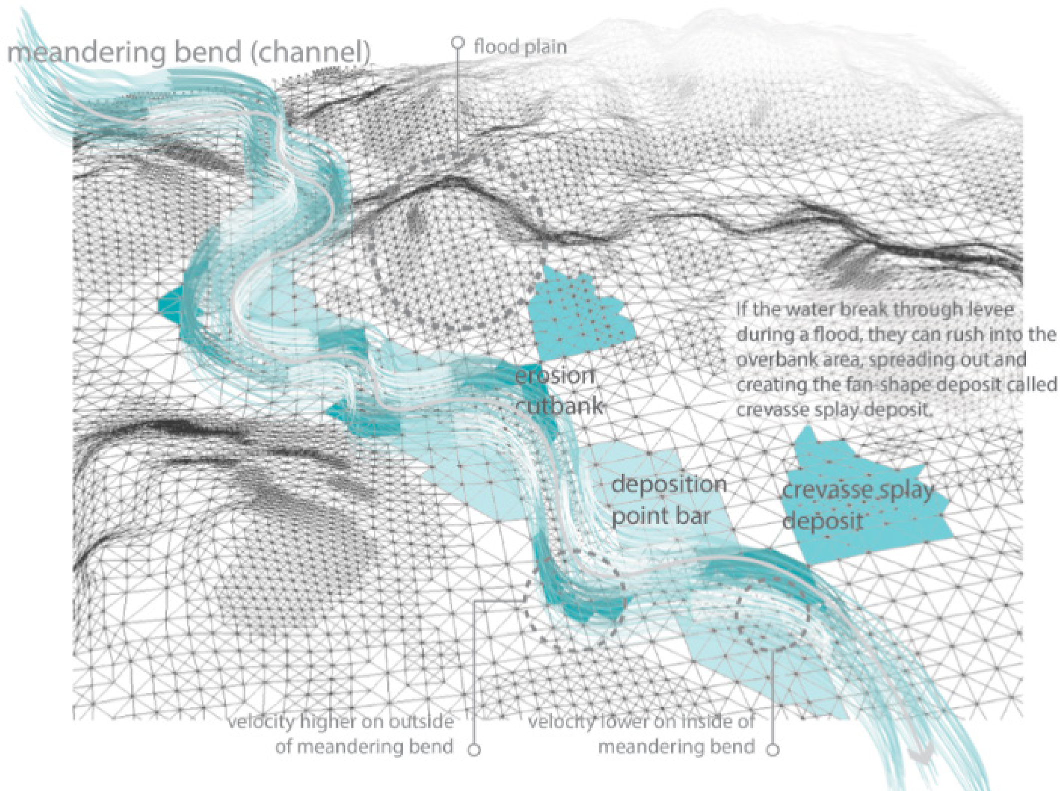

Figure 22: Three Zones of Meandering River
Three zones of meandering river are instructive for designing different-function infrastructures in different zones.

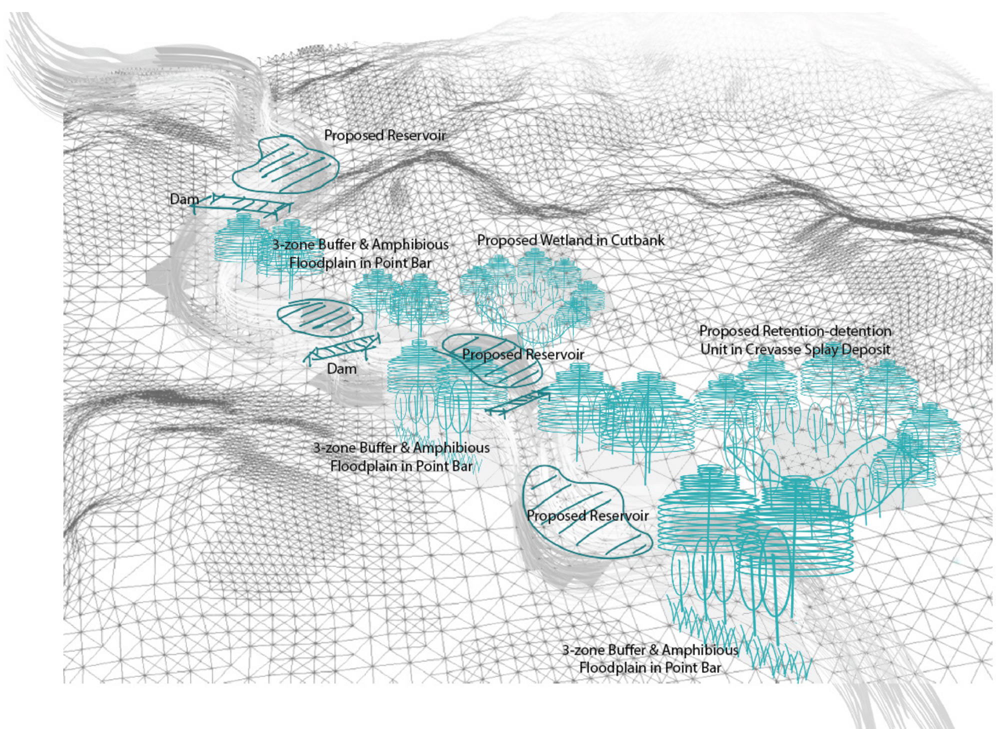

Figure 23: Proposed Infrastructures on Three Zones of Meandering River
Different infrastructures are proposed in different zones.

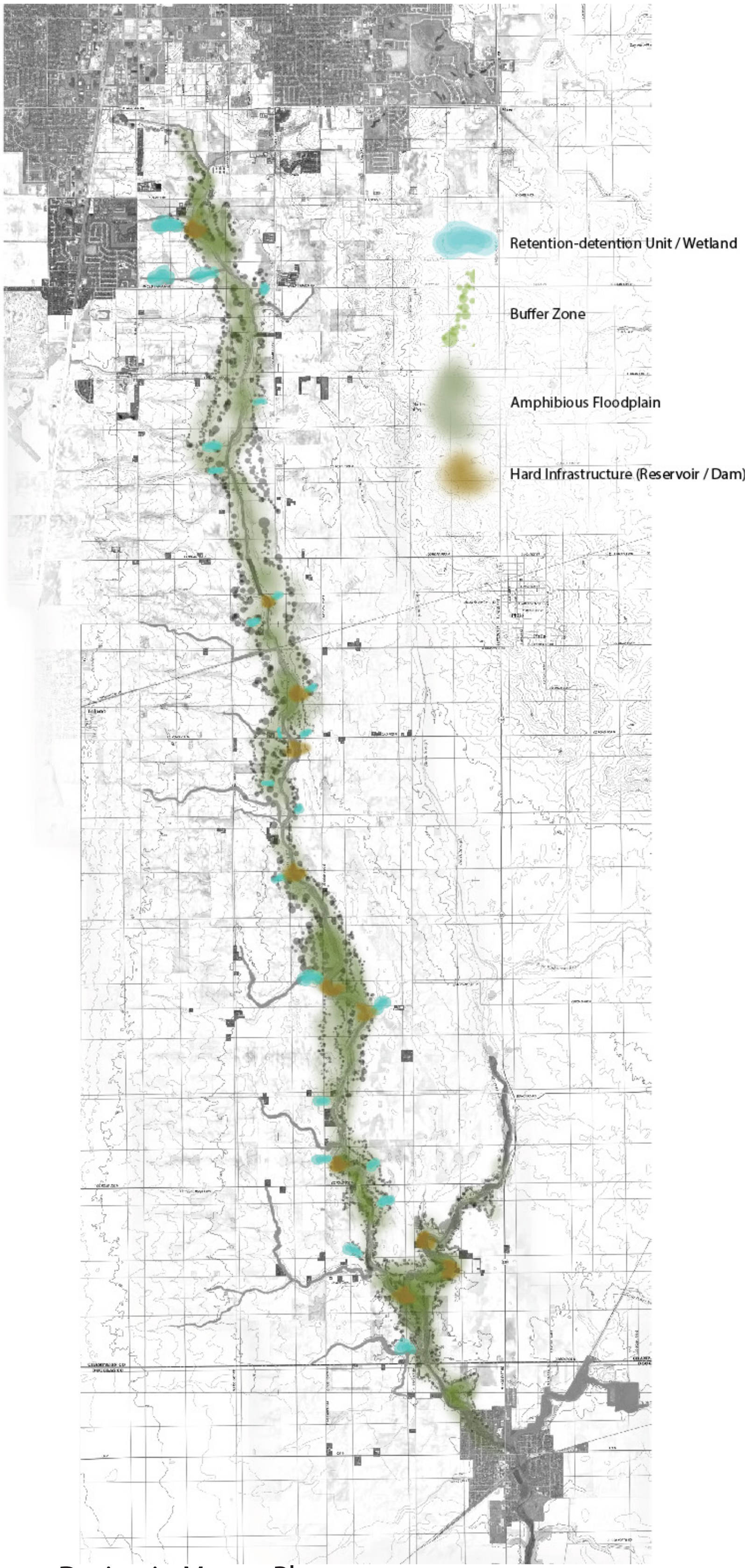

Figure 24: Infrastructure Design in Master Plan
This master plan indicates different infrastructures' design.

There are multiple infrastructures proposed in the design, as shown in Figure25. To be specific, green infrastructure includes wetlands, retention-detention units, and buffer zones. Grey infrastructure involves small reservoirs, dams and levees. By combining green and grey infrastructure, the issue of flood can be controlled to a large extent. At the same time, some green infrastructure help improve runoff quality before reaching the river. For example, buffer zones slow water runoff, enhance infiltration, trap pollutants in surface runoff, etc. (Bentrup, 2008). In addition, retention-detention units can improve water quality and assist with flood management by reducing the most of annual and peak runoff and sewer surcharges (Locatelli, 2015), as well as depositing the most sediments at the bottom of ponds.

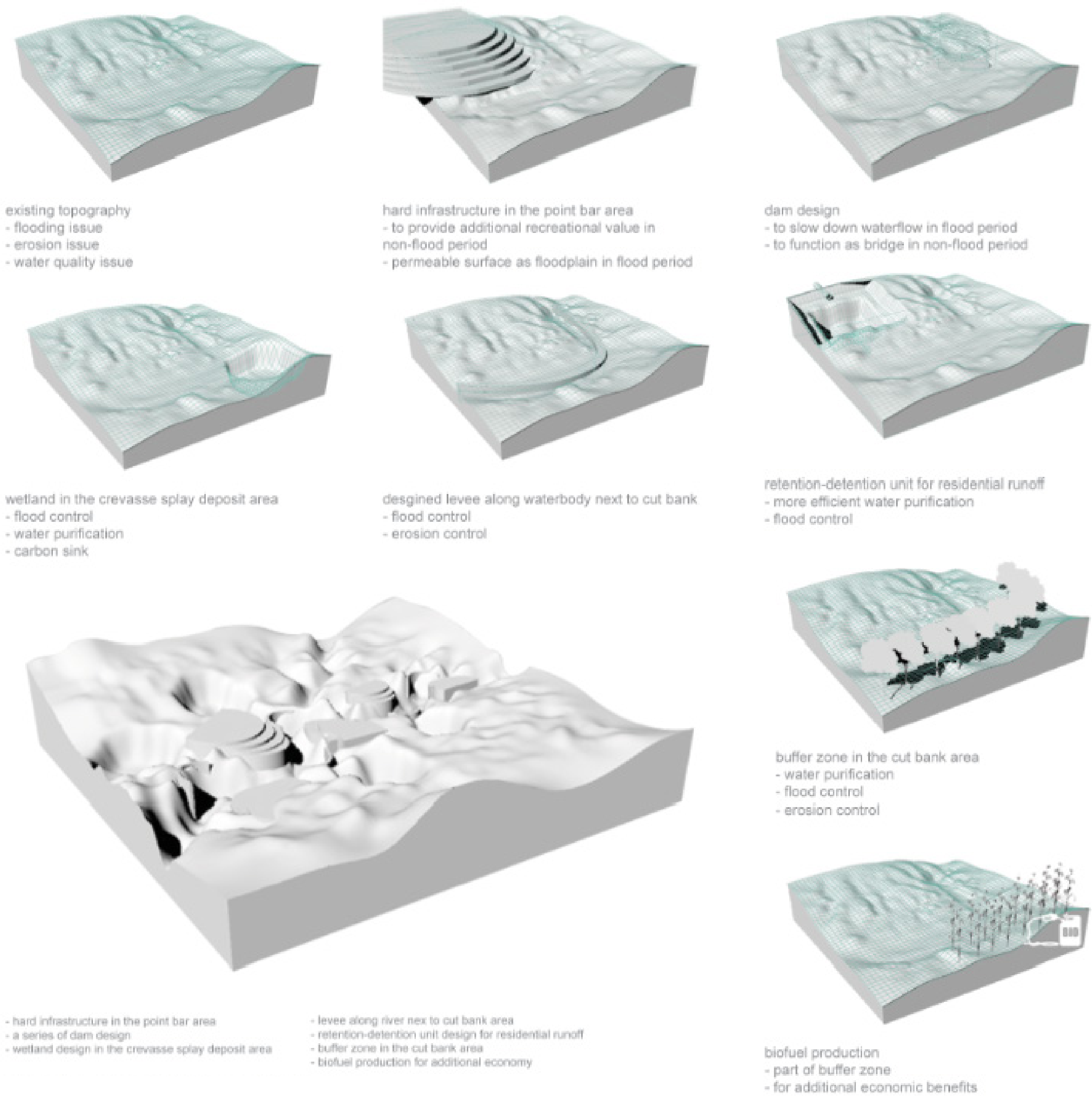

Figure 25: Infrastructure Catalog
Infrastructure Catalog indicates what infrastructures can be used in the design.

Located between Champaign and Villa Grove, the amphibious and hybrid infrastructure system has various benefits for both Champaign and Villa Grove communities (Figure 26). First of all, it provides recreational spots and greenways for the residents in both communities. Secondly, the riverfront areas bring educational and economic benefits for the residents by offering them space to get in touch with the Embarras river that was the biologically significant stream with endangered species in history. Thirdly, hybrid of green and grey infrastructure maximizes the functions to assist with flood management. Fourthly, green infrastructure also improves water quality besides assisting with flood management, which leads to a better water environment for more aquatic species including endangered species.

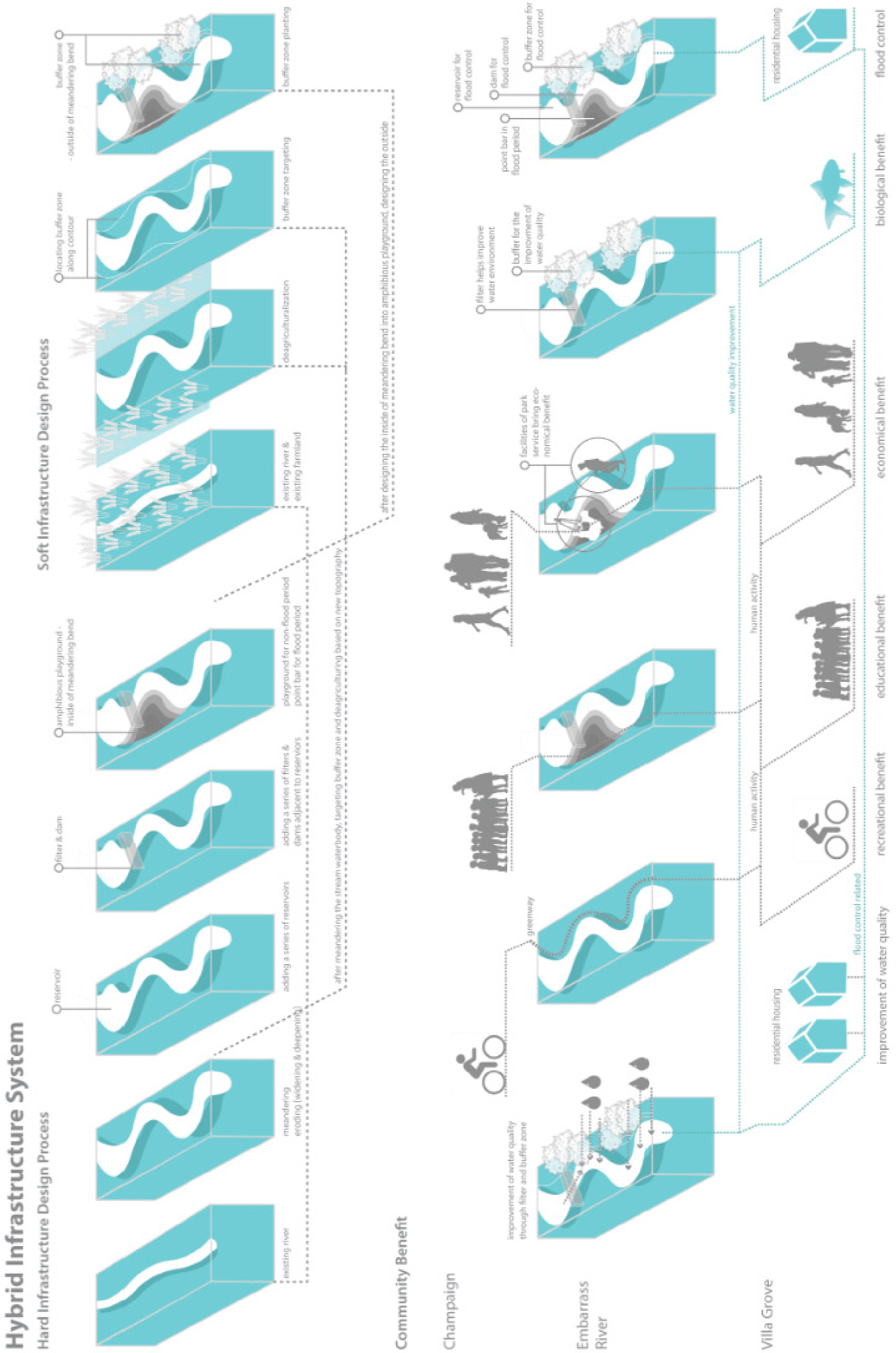

Figure 26: Hybrid Infrastructure System and Its Benefits to Communities
This digram indicates the processes of designing the hybrid infrastructure system, as well as the benefits for both Champaign and Villa Grove.

4.3 Recreational Greenway

Close to the University of Illinois campus and Villa Grove, it is potential to develop recreational greenways for residents living in Villa Grove and Champaign, especially on campus. There is a huge opportunity to create stronger connections among agricultural, environmental and recreational industries in order to explore probability of the region.

Multiple recreational activities are involved in different zones to rejuvenate the programs of the river, as shown in the master plan in Figure 27. As indicated in Figure 28, potential programs involve jogging, walking and biking along the greenway, and group activities in floodplain area in non-flood period, such as educational touring, resting and chatting, playing and enjoying the river view, etc. With consideration of the issue of lack of identity, this naturalistic landscape along the river incites various programs, bringing recreational, educational, social and economic values to the site, in which way the identity of the UER will be enhanced.

Figure 27: Recreational Greenway
This diagram shows where the recreational greenway goes.

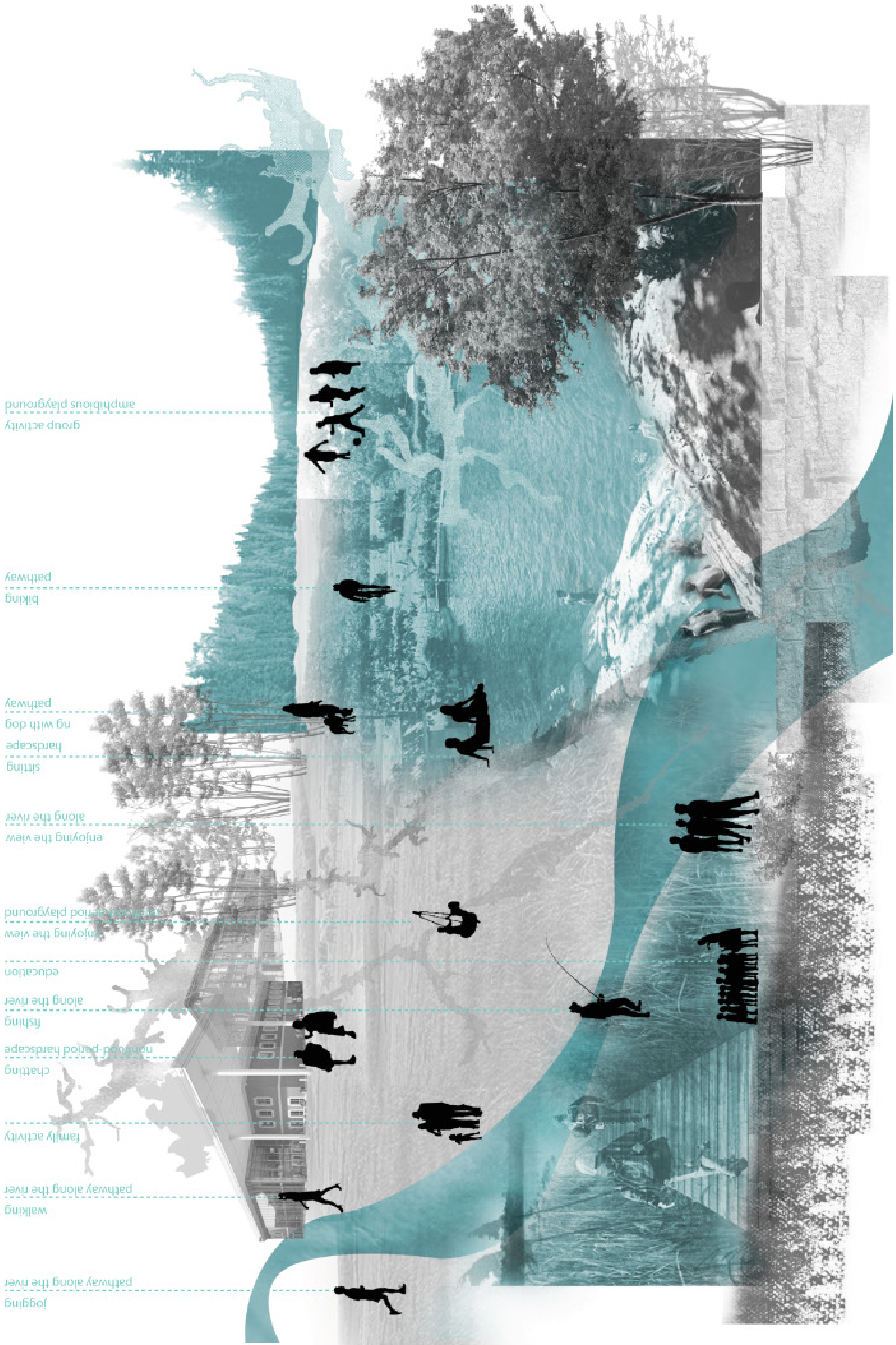

Figure 28: Recreational Program Catalog
Multiple programs potential for the proposed site have been indicated in this diagram.

CHAPTER 5: DESIGN

5.1 Conceptual Framework

Based on the issues, potential and strategies, the design will be proceed through the following steps (Figure 29):

a. Recovering the river by meandering, widening and deepening its water body.

b. Protecting the river by designing amphibious landscape infrastructure and 3-zone buffers along the contour line.

c. Reconnecting the river with other natural features and residential areas, providing people access to the whole natural system.

d. Rejuvenating the river by integrating recreational trails within the natural system.

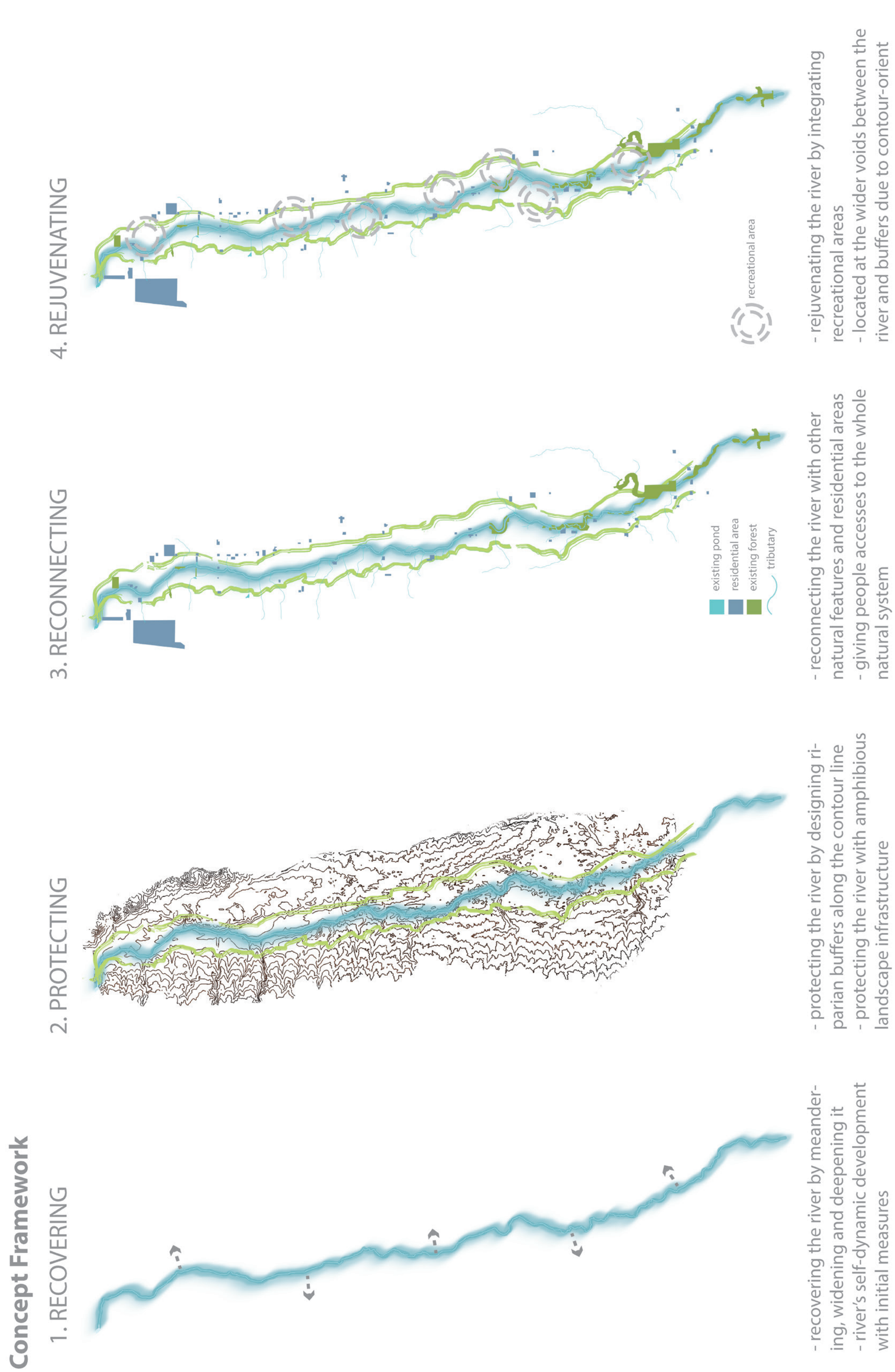

Figure 29: Conceptual Framework
Conceptual Framework shows four significant processes of the design: recovering, protecting, reconnecting and rejuvenating.

5.2 Master Plan

Aimed at the above four issues, the final design combines three strategies: 3-zone buffer, amphibious infrastructure, and recreational greenway. Overall, this natural riverscape creates ecological restoration for river, relieves flooding for Villa Grove, serves as a habitat for terrestrial and aquatic species, and provides recreation for residents that brings not only recreational, but also education, social and economic values to the site.

Figure 30 is the master plan for the whole site, including buffer zone, hybrid of green and grey infrastructure, and areas for recreational programs.

Figure 30: Master Plan
Master plan shows all three strategies including 3-zone buffers, hybrid infrastructures and recreational greenways.

Corresponding to the concept framework mentioned before, the master plan is developed through adding multiple layers, fulfilling the processes in the concept framework. By adding layers of residential networks, hydrology, infrastructure, and community, the UER both ecologically and recreationally transforms from a single-functional river into a riverscape that is embedded in its context. The layers are dominant considerations when applying the strategies onto the site, which is shown in the layered master plan in Figure 31.

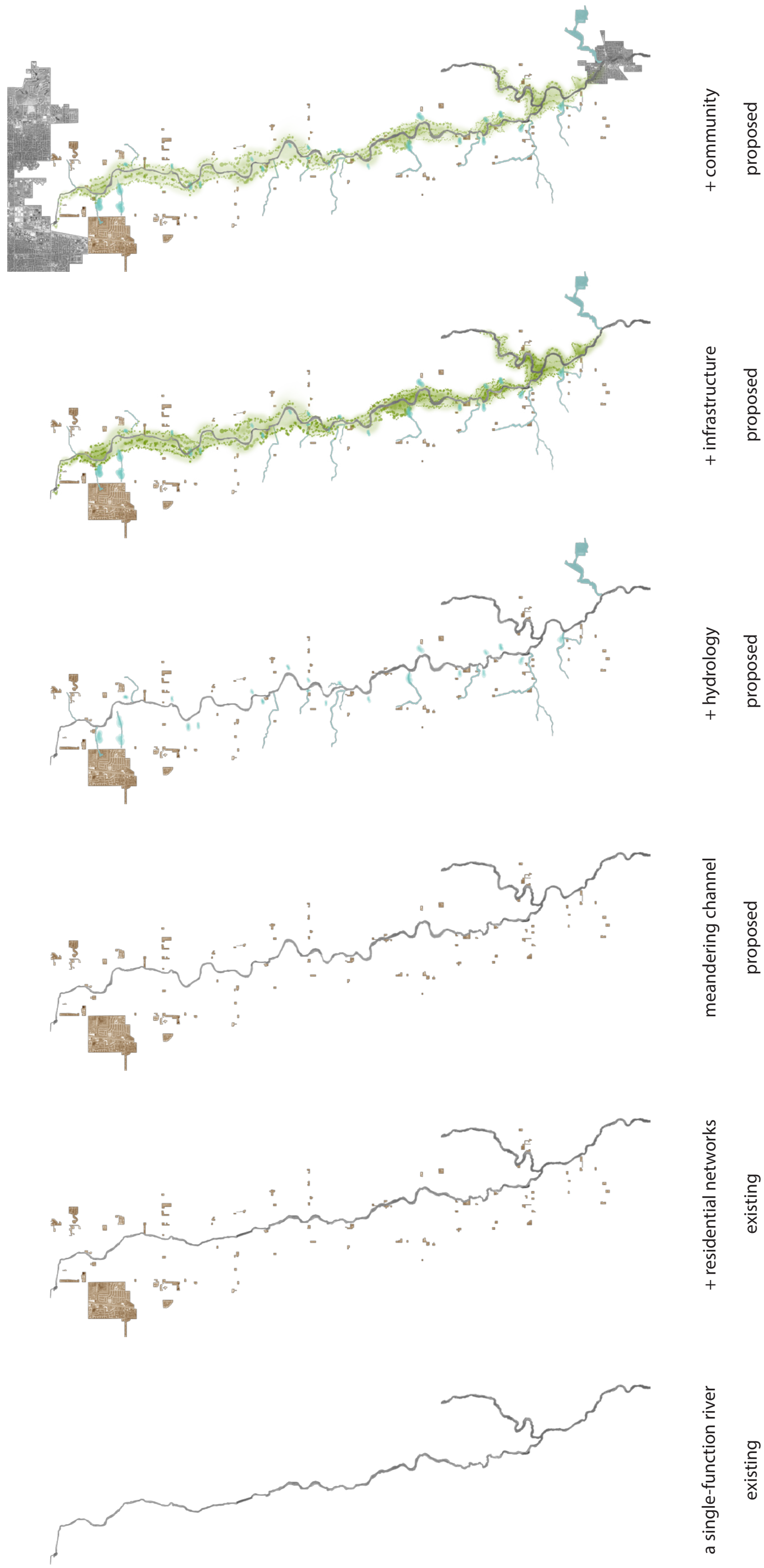

Figure 31: Master Plan with Layers
Six layers are indicated in this figure that are added during design process: existing river channel, residential networks, meandering channel, hydrology, infrastructure, and community.

Existing site is a single-functional sector of the Embarras River. By adding residential network, it reveals the hidden network of residential areas, the hidden relationship between the river and residential areas, and the potential for future development. The third layer in hydrology indicates ignored river branches, which in turn functions significantly in flooding period. Infrastructure involves the existing infrastructure and proposed infrastructure. Proposed infrastructure is predominantly comprised of 3-zone buffers, natural floodplains, reservoirs, dams, wetlands, retention-detention units, etc. By adding community layer, the site is reconnected with the two communities (Champaign and Villa Grove) indicating the potential engagement of the residents from these two communities. These five layers are significant to figure out the layout of different elements from the three strategies.

Residential network demonstrates the locations of residential areas, which helps locating the first scenario. The first scenario focuses on the sites close to residential areas that require the wastewater treatment from residential houses. In such areas, retention-detention units are designed between residential houses and the river in order to treat wastewater before it flows to the river. At the same time, the areas around retention-detention units are designed into riparian wetlands, providing recreation for users and ecological restoration for riparian landscape.

The hydrology layer includes existing tributaries of the Embarras River and proposed hydrological infrastructures, such as wetlands, retention-detention units, etc. Hydrological infrastructures are proposed to be located close to existing tributaries, making full use of existing water resources. In addition, the locations of hydrological infrastructures are also designed based on the River Morphology Theory. For example, the areas outside the meandering bend, called erosion cutbank areas, are ideal sites for retention-detention units. It is because the flow velocity is higher on the outside of meandering bend. During flooding periods, water flows will break through levees and first rush into the erosion cutbank areas with higher flow velocity compared to the water flow inside the meandering bend. As a result, retention-detention units in erosion cutbank areas will help relieve the flooding in the first place.

The community layer emphasizes the engagement of the residents in Champaign and Villa Grove. This layer indicates that the proposed riverscape is not only ecologically valuable, but also recreationally and culturally beneficial to local residents.

5.3 Detail Design

In order to further illustrate the strategies, two specific locations are chosen to demonstrate the design in master plan and perspective, according to different site conditions. Two sites include Site A close to residential areas north of UER, and Site B close to Villa Grove south of UER (Figure 32).

Figure 32: Site A and B in Master Plan
Two sites are selected for detailed design.

Scenario A

The design for Site A represents the scenario close to residential areas which are next to the residential areas in Savoy, between Curtis Road and Old Church Road. The existing site between the residential area and the river is agricultural lands with two tributaries flowing through it. One tributary connects a lake and the river. And water flows through the other one only in flooding period. According to 303(d) list, this sector of the river is mainly impaired by untreated residential wastewater. Figure 29 indicates the existing condition through the site view.

Figure 33: Existing View of Site A

Figure 34: Existing View of Site A

Figure 35: Existing View of Site A

Figure 33, 34 and 35 indicates that there are few buffers to protect river and it easily tends to flood, influencing residential areas. And there are enormous open spaces potential for development.

Figure 36 indicates the master plan of Site A. The perspective view is shown in Figure 37. Aimed at the water quality issue, retention-detention ponds can reduce peak and annual runoff volumes and sewer surcharges to the largest extent. In addition, retention-detention ponds can function for flood control as well as provide access to water for residents. So having the aid of the existing tributaries, I propose a series of retention-detention ponds along one of the tributaries not only for ecological purposes, flood control and runoff treatment, but also providing waterfront activities for residents.

A wetland is designed at the other tributary. The wetland collects water to help relieve flood pressure for Villa Grove and serves as the buffer zone between the river and the residential area during flood periods. Furthermore, it also provides a refuge for a variety of species, increasing biodiversity and encouraging people to enjoy watching different kinds of animals and plants. It also creates a platform for water related activities, in which way the identity of the river will be increased. People have the opportunity to change their perspective about this so-called-ditch river.

Buffer zones are also designed along the river, protecting river from polluted runoff before water arrives at the river body. In addition, buffer zones provide protection, shades and visual scenes for users who walk and bike on the greenway along the river. Moreover, in order to increase interesting and various programs for residents, boardwalks are designed across retention-detention ponds and wetlands.

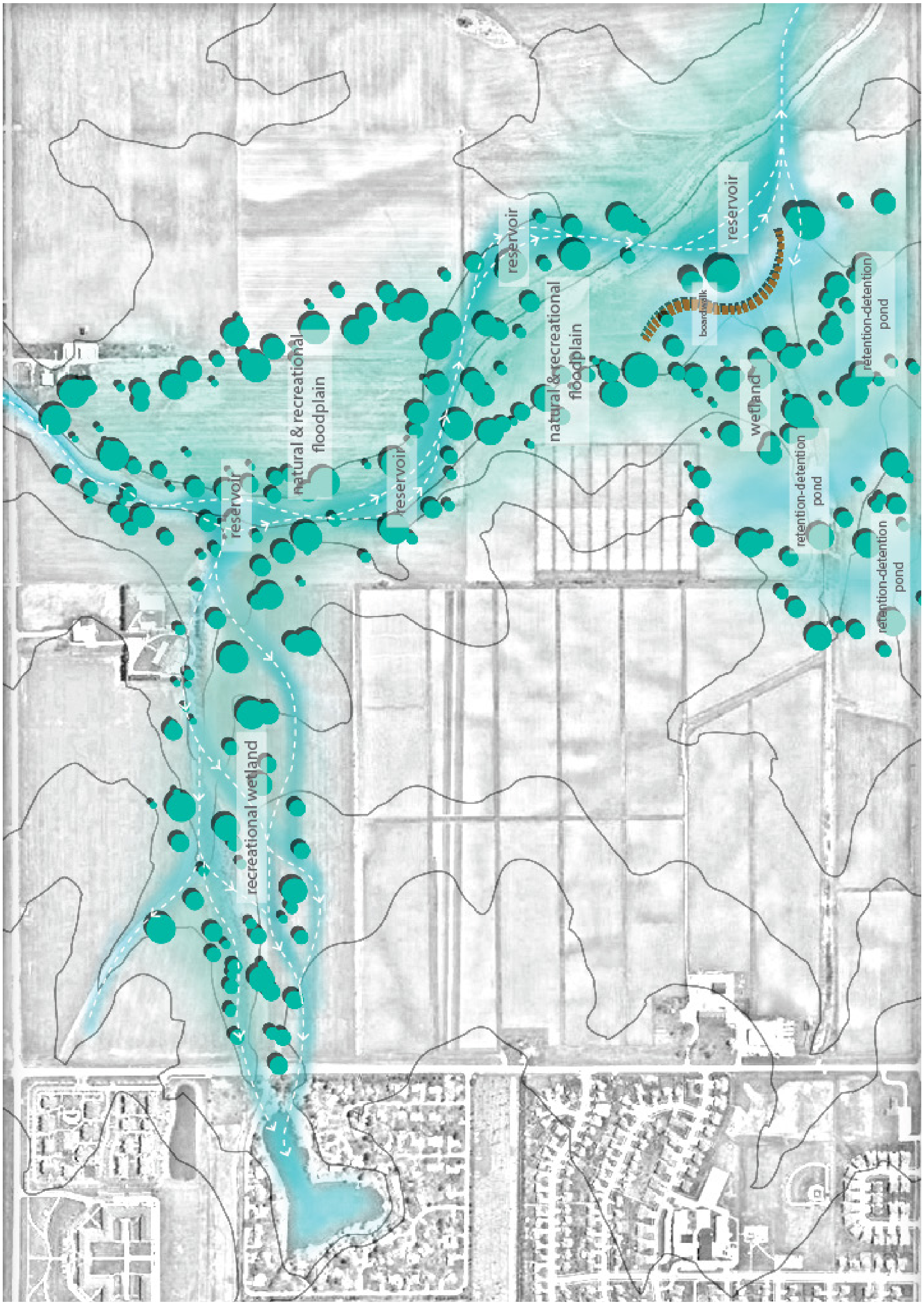

Figure 36: Site A Master Plan
The master plan indicates the landscape design next to residential area.

Figure 37: Site A Perspective
This perspective demonstrates the designed landscape view in Site A. The natural-style landscape provides a recreational space for the residents. It also plays the ecological role.

Scenario B

Site B is located close to Villa Grove, which is designed as a significant site to assist with flood management to relieve the flood pressure in Vila Grove. The existing river channel is wider and with more buffer plants than other sections (Figure 38, 39). The existing site is highly potential to flood, but without any flood treatment. So the existing site is highly potential to be designed into flood management site with flood control infrastructures. Because this site is close to Villa Grove, it can help relieve flood for Villa Grove and provide space for recreational activities for residents in Villa Grove as well.

Figure 38: Existing View of Site B

Figure 39: Existing View of Site B

Figure 38 and 39 indicate that there are more buffer trees and wider than other sections of the study stream. And there are large areas of vacant land potential for flood control and development for recreational purpose.

Figure 40 shows the master plan of Site B. The perspective is indicated in Figure 41. Considering the flood issue, first of all, the river bed is widened and meandered, slowing the flow velocity into Villa Grove. Secondly, a natural flood plain is proposed in each inside area of the meandering bend to assist with flood management in flood periods. In such areas, sedimentation of silt by the inward flow forms point bars (Dietrich, 1983), where the slope is gentle, and the elevation is close to water level. In result, these areas will be easily overtaken by flood. So I design these areas into natural flood plains, serving as flood plains in flood periods and recreational grounds in non-flood periods.

Moreover, other green and grey infrastructure is also designed to relieve flood pressure, including buffer zones, retention-detention units, wetlands, reservoirs, dams, and levees. Specifically speaking, retention-detention units and wetlands are proposed in cut banks. As opposed to point bars, cut banks are formed by erosion, which means they are unstable. So I propose buffer zones in such areas in order to reduce erosion. In addition, wetlands and retention-detention units are also designed here to relieve flood pressure.

In particular, buffer zones and retention-detention units also improve water quality, by which the river is enhanced to create better living environment for more specie. Finally, the designed flood plain will serve as recreational playground in non-flood periods.

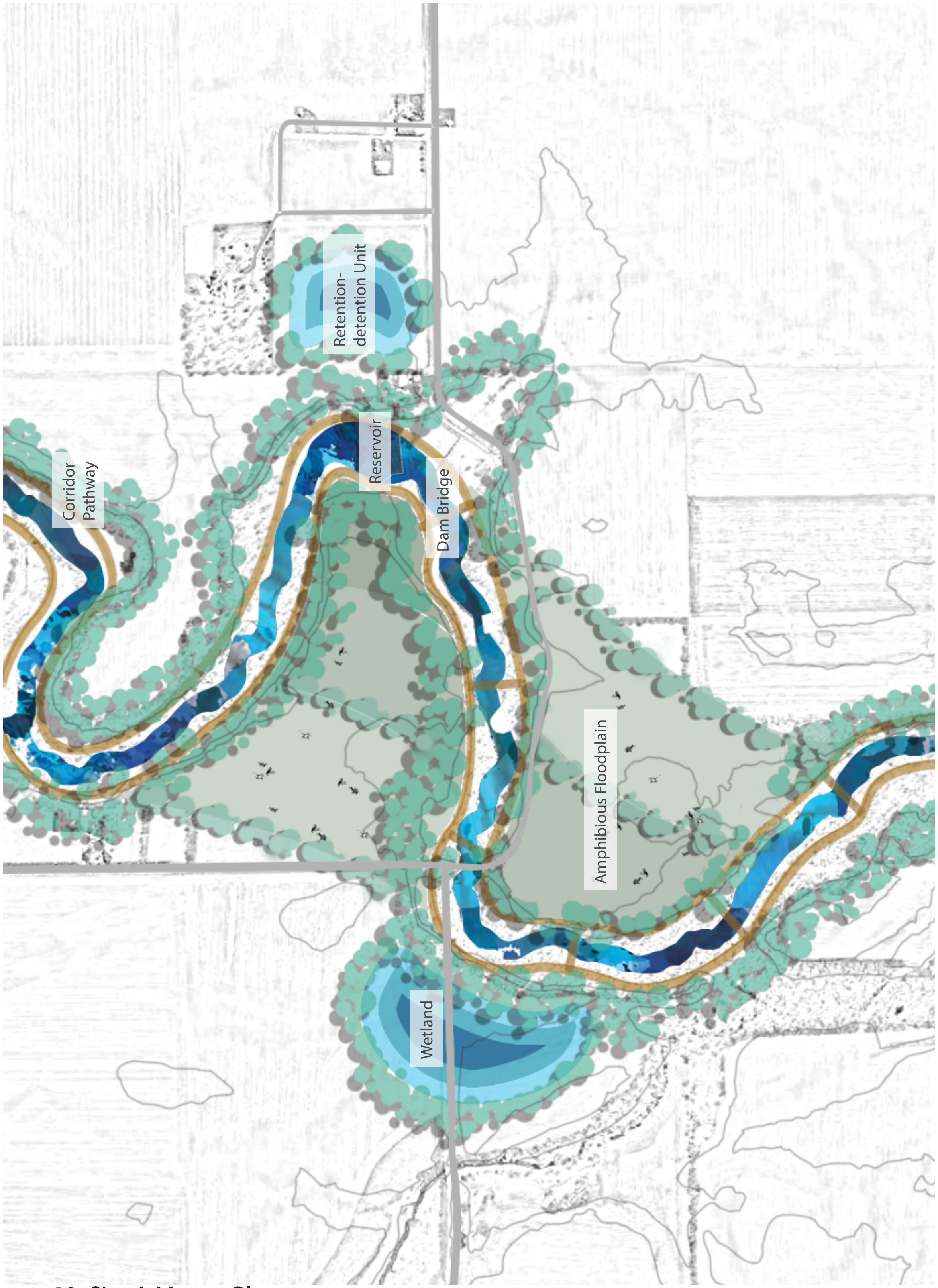

Figure 40: Site A Master Plan
Site A Master Plan involves all strategies and designs, including 3-zone buffers, amphibious floodplains, reservoir, dam bridges, recreational greenways, retention-detention units, and wetlands.

Figure 41: Site B Perspective
This perspective shows the natural landscape view in site B. The amphibious floodplain acts as a recreational activity area with buffers providing aestheric views and shades.

5.4 Flood Calculation

Through designing various infrastructures in this thesis research, the flood control rate of the proposed river in this thesis research is 82.7%, which helps relieving the flood issue at Villa Grove to a large extent. The detailed calculation processes are indicated below.

Existing: In the model of the one percent annual chance flood, a.k.a the 100-year floodplain, the estimated flood discharge for the Embarras River at Villa Grove is 10,370 cfs (cubic feet per second) and 32 hours (McConkey, 2002).
32 hrs = 32 x 60 x 60 = 115,200 second
10,370 cfs x 115,200s = 1.195 x 10^9 cubic feet (cf)
So the estimated flood volume at the Villa Grove is 1.195 x 10^9 cubic feet.

In addition, the existing flood discharge for the Embarras River above Villa Grove is 5,734 cfs and 32 hours.
32 hrs = 32 x 60 x 60 = 115,200s
5,734 cfs x 115,200 = 6.6 x 10^8 cf
So the estimated flood volume above the Villa Grove is 6.6 x 10^8 cubic feet.

1.195 x 10^9 cf + 6.6 x 10^8 cf = 1.85 x 10^9 cf.
In conclusion, the total existing flood volume of the UER is 1.85 x 10^9 cubic feet.

Proposed: In my proposed river model, there are the following water control infrastructures holding flood water: meandering river bend, floodplains, retention-detention units, and natural reservoirs. The flood volumes that they are capable to hold are as below:
1. Meandering River Bend: The existing meandering river bend is 88,371 feet long, 50' wide, 4' depth.
The area of the river profile: 134 square feet (sf)
The volume of the meandering river bend: 134 sf x 88,371 ft = 11,841,714 = 1.18 x 10^7 cf
So the proposed volume of the meandering river bend is 1.18 x 10^7 cubic feet.
2. Floodplains: 1.87 x 10^8 cf
3. Retention-detention Units: There are 25 proposed retention-detention units. As for each retention-detention unit, the proposed average area is 1,504,994 sf. And the standard depth of a retention-detention unit is 6 ft[1]. So the volume of one retention-detention unit is 1,504,994 sf x 6 ft = 9.1 x 10^6 cf. The total volume of 25 retention-detention units is 9.1 x 10^6 cf x 25 = 2.28 x 10^8 cf.

4. Natural Reservoirs: There are 11 proposed natural reservoirs in total. It is 10^8 gallons (cubic feet) per proposed natural reservoir. So the total volume of proposed natural reservoirs is $11 \times 10^8 = 1.1 \times 10^9$ cf.

In total, the flood volume that the proposed infrastructures hold is:
1.18×10^7 cf + 1.87×10^8 cf + 2.28×10^8 cf + 1.1×10^9 cf = 1.53×10^9 cf.

The Proposed Flood Control Rate = proposed flood control volume / existing flood volume
= 1.53×10^9 cf / 1.85×10^9 cf = 82.7%
So the flood control rate of the proposed river in this thesis research is 82.7%.

From these calculations, there is great potential for flood mitigation along the Upper Embarras River so that to relieve flood pressure in Villa Grove. Moreover, these flood management infrastructures not only function to control flood, but they also serve as pollution filters for water and recreational space for residents, which make the site valuable and multi-beneficial.

CHAPTER 6: CONCLUSIONS

This thesis research focuses on redefining traditional landscapes of the rivers across agricultural lands by studying the upper section of the Embarras River (UER) in Champaign County, Illinois. The UER shares common issues with most rivers, such as water quality issue and species extinction. In addition, the river is considered as a ditch instead of a river by the surrounding agricultural communities, despite it was a biologically significant stream in history. Moreover, the most important reason that I chose the UER is because Villa Grove, that is located just downstream of the site, is suffering serious flood issue. The UER has great potential to help control the flood in Villa Grove. All the reasons above make this site suitable for the site-specific study for my thesis research. By doing such research, I created a design for the UER, which can be applied to other sites in similar situations.

Starting from studying river morphology theory, I explored riparian buffers, green and grey infrastructures, and recreational greenways. By doing such research, I figured out how to design different infrastructures with different functions and site-condition requirements into different river zones that are formed by erosion and sedimentation during long-time water flows of meandering river bend.

During the site-specific research and design, I focused on four issues of the site, impaired waterway, extinction of endangered-species, flooding, and lack of identity. Based on these issues, I created three strategies, 3-zone buffer, hybrid infrastructure and recreational greenway. To be specific, 3-zone buffers function to reduce runoff and improve water quality before it reaches the river bend. By improving water quality, this strategy also improves the habitats of multiple species. In addition, 3-zone buffer, that is also a type of green infrastructure, also helps control flood by creating floodplain and absorbing water by their strong root systems. The second strategy, hybrid infrastructure, mainly acts to control flood by keeping more water from Villa Grove. Flood calculations show that the strategies proposed would relieve flood by 82.7%. Finally, recreational greenway provides recreational areas for users to conduct various recreational activities, by which people, especially residents in Champaign County and Villa Grove, are offered opportunities to learn more about the river's history, current condition, and future development opportunities.

Here is what I think of this research and design. This thesis research was started with the general question, how I redefine traditional landscape of the river running across agricultural lands. Carrying this question, I did a systematic study on the UER through analytical and design approaches. The design is specific to the Upper Embarras River. However, the analytical and design approaches are applicable to a broad range of conditions. The design illustrates the utilities of three strategies, and it can easily be modified to fit other site conditions. Moreover, the analytical and design approach used in this thesis research should be reconsidered thoroughly as a general approach in the discipline of Landscape Architecture. Landscape design is not only design through designer's brainstorms, but it should also be treated as a systematic design through research. All the design processes are logically based on the research of the site's conditions, scientific data, scientific methods, scientific strategies, etc. Landscape design is not only about landscape, but it also involves many other disciplines, such as civil engineering and architecture.

The next steps involve getting inputs from users and making detailed modeling for the river morphology and the quality and quantity of hybrid infrastructure, including 3-zone buffer. The input from users is the expansion for the strategy of recreational greenway. Its significance should be tested and revised based on the inputs from users. The detailed modeling is developed from the 3-zone buffer strategy and the hybrid infrastructure strategy. They need more technological approaches to support the research and test the efficiency and impacts of all the landscape infrastructures.

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